THE COMINCO STORY

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMIT

No man is an iland, intire of it selfe; every man is a peece of the Continent, a part of the maine; if a Clod bee washed away by the Sea, Europe is the lesse, as well as if a Promontorie were, as well as if a Mannor of thy friends or of thine owne were; any man's death diminishes me, because I am involved in Mankinde; And therefore never send to know for whom the bell tolls; It tolls for thee. (John Donne)

. . . the enterprise that no one man could build was built by many working together. It is to its employees, past and present, that The Cominco Story is dedicated.

The Cominco Story

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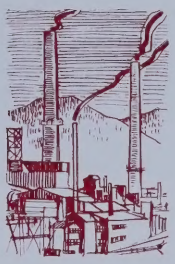

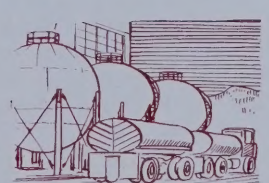

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COMINCO

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED

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Cominco Today

A Great Canadian Enterprise

THROUGH more than half a century of operation, The Consolidated Mining and Smelting Company has grown to rank with the world's major producers of non-ferrous metals and chemical fertilizers. In terms of trade Cominco is international in scope. Its operations and interests, however, are located mainly in Canada. The Company has activities from coast to coast and in the Northwest Territories, although the major production facilities are centered in the Kootenay districts of British Columbia. Total employment is about 7,500.

The listing which follows will help to orient the reader geographically:

Montreal, Quebec

Head Office; the principal offices for metal, chemical and fertilizer sales; market research; sales development; an exploration office. Personnel number 150.

Trail, B.C.

Administrative offices and main offices for the exploration, mines, metallurgical, chemical and fertilizer, engineering, research and development, personnel, purchasing, comptroller's and legal divisions. Major plants are the Lead Smelter, Lead Refinery, Silver Refinery, Zinc Plant, Metal Fabrication Plant, Sulphuric Acid Plants, Hydrogen Plant, Ammonia Plants, Ammonium Phosphate Plant, Ammonium Sulphate Plant, Nitric Acid Plant, Ammonium Nitrate Plant, Chlor-Alkali Plant, Electronic Materials Plant. Centralized engineering services including large shops. Centre for power distribution. Head office of the West Kootenay Power and Light Company, Limited. Personnel number about 4,000.

Kimberley, B.C.

Sullivan Mine (lead-zinc-iron), Sullivan Concentrator, Kimberley Fertilizer Department (producing ammonium phosphate fertilizers), Iron and Steel project. About 1,500 are employed.

Riondel, B.C.

Bluebell Mine (lead-zinc) and Concentrator, employing 280.

Salmo, B.C.

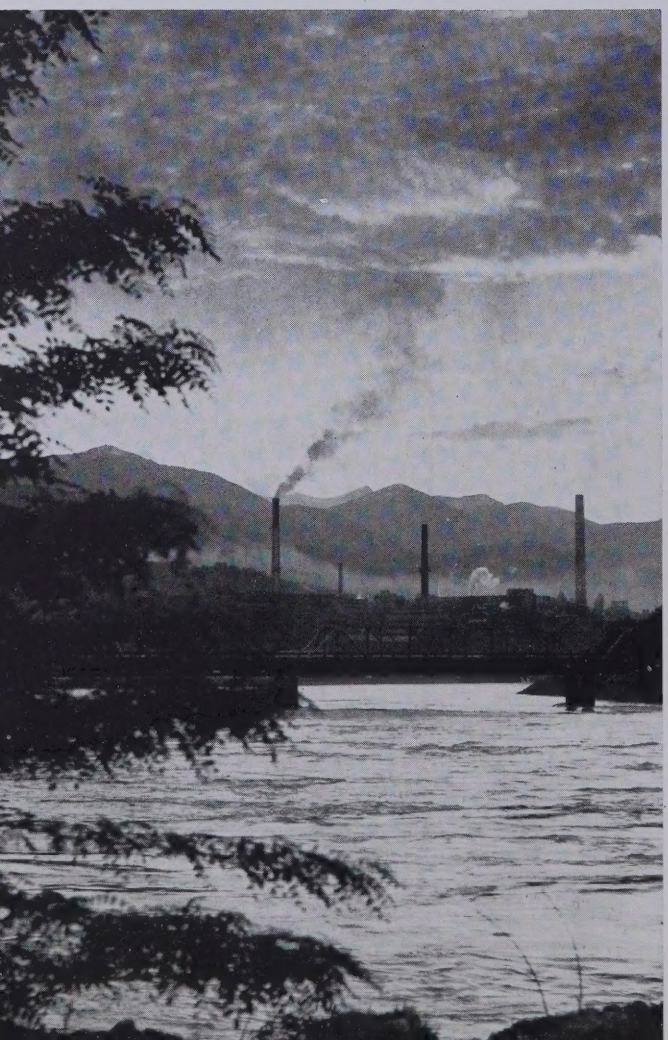
H. B. Mine (zinc-lead) and Concentrator, employing 110.

Kootenay and Pend-d'Oreille Rivers

Four hydro-electric plants on the former and one on the latter river. A plant of the West Kootenay Power and Light Company on the Kootenay River.

Calgary, Alberta

Alberta Nitrogen Department, producing ammonia, ammonium nitrate (Nitraprills) and urea. About 325 are employed. Headquarters for fertilizer sales in Western Canada.



Stacks tower over Cominco's metallurgical operations beside the Columbia River at Trail, B.C. Ore from the Rossland Mountains in the background prompted construction of the original smelter before the turn of the century.

Yellowknife, N.W.T.

Con Mine (gold). Small hydro-electric plant at nearby Bluefish Lake. Personnel number 200.

Garrison, Montana

Phosphate rock mining operations.

Tulsequah, B.C.

Gold-base metal mine (operation suspended at present).

Vancouver Island

Majority interest in the Coast Copper Company Limited.

Vancouver, B.C.

Sales and shipping offices. At nearby New Westminster and Port Moody, B.C., a majority interest in Pacific Coast Terminals Limited warehousing, docking and loading facilities.

Spokane, Washington

Offices, storage for dry fertilizers, liquid fertilizer storage and conversion facilities of the subsidiary company, Cominco Products, Inc.

Pine Point, N.W.T.

Majority interest in a substantial lead-zinc ore deposit.

Wellington Lake, Saskatchewan

Small hydro-electric plant.

Saskatoon, Saskatchewan

Fertilizer sales office.

Winnipeg, Manitoba

Fertilizer sales office.

Port Arthur, Ontario

Exploration office.

Cominco has made substantial contributions to recreational facilities in communities where employees live. The Trail Memorial Centre includes the Cominco Arena and Cominco Gymnasium, both donated by the Company.

Toronto, Ontario

Metal sales office.

Dresden, Ontario

Zinc die casting plant of the subsidiary company, National Hardware Specialties Limited.

Wallaceburg, Ontario

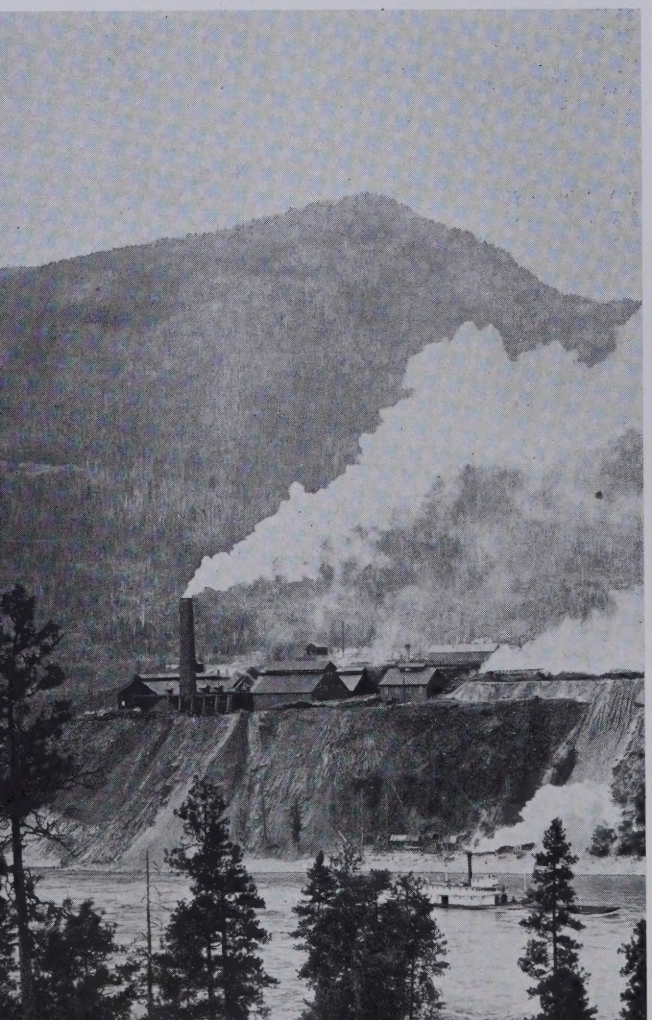
Plating and finishing facilities for die castings of the subsidiary company, Lustre Corporation.

Bathurst, New Brunswick

Underground development work in progress at the Company's nearby Wedge copper property; also an exploration sub-office.

The History of Cominco

Born with a Bold Resolve



THE Cominco story had its beginning with the discovery of gold-copper ore in B.C.'s West Kootenay district in 1890 by prospectors Bourgeois and Moris. Fortune-seekers soon followed them to the strike and Rossland, B.C. was born. It mushroomed quickly into a colourful boom town. By 1895 almost 2,000 claims had been staked in the vicinity. The early Rossland mines were severely handicapped by having to ship their ore to Montana for treatment. Transportation was by wagon to Trail Creek Landing, then by paddle-wheeler down the Columbia River to railhead in the United States. This costly procedure led F. A. Heinze of Butte, Montana, to build a small copper smelter at Trail and a railway to the Rossland mines in 1895-1896.

In 1898 the Canadian Pacific Railway Company purchased Heinze's railway, some railway rights which he had obtained, and the smelter, operating the latter as the Canadian Smelting Works. A lead blast furnace was installed at the smelter in 1899. For a short time the lead bullion produced from Kootenay district lead ores was shipped to the United States for refining. An electrolytic Lead Refinery was built at Trail in 1902, using the new Betts process for the first time. This plant, which had a 50-ton-per-day capacity, produced Canada's first refined lead, the first electrolytic lead in the world.

Early in 1906 The Consolidated Mining and Smelting Company of Canada Limited was formed. This Company came into existence as a consolidation of several interests: the plant at Trail, the War Eagle and Centre Star mines at Rossland, the St. Eugene Mine at Moyie, and the Rossland Power Company. The new Company employed about 1,000 people. It was fairly large in terms of the times, and it had been born with a bold resolve (see back inside cover).

The ore supply for the new Company consisted of gold-copper ore from the Rossland mines, purchased lead-silver ore from the Slocan and Kaslo districts of the West Kootenay, and lead-silver ore from the Company's St. Eugene Mine at Moyie in the East Kootenay. The St. Eugene outcrop had been discovered by an Indian before the turn of the century. The mine had been developed, but reserves were limited. Cominco's attention soon turned to finding new sources of ore. One of the many properties examined was the Sullivan Mine at Kimberley, B.C. This mine had been discovered in 1892, but successful production had not been achieved because of the difficulty of treating the highly complex lead-zinc-iron ore. An investigation of

The pioneer smelter at Trail was built to treat gold-copper ore from the Rossland mines. A relatively small plant in 1897, it became the nucleus of Cominco's operations when the Company was formed in 1906.

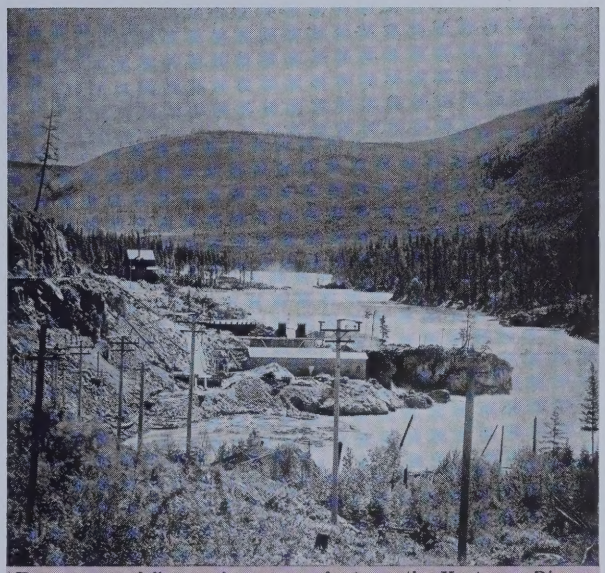
the property led to the belief that it could be operated successfully by selective mining and hand-sorting until effective treatment methods were worked out. The Company obtained a lease on the mine in 1909 with an option to purchase. The option was exercised in 1910.

During World War I Cominco was one of three companies requested by the Imperial Munitions Board to produce zinc. A pioneer electrolytic Zinc Plant with a 30-ton daily capacity was constructed at Trail in 1916 to treat crude zinc ore from the Sullivan Mine. Despite numerous difficulties, World War I output of the vitally-needed metal exceeded 20,000 tons.

Many methods for the economic separation of the components of the Sullivan ore were tried. In 1917 an investigation of flotation processes was undertaken, and painstaking research eventually resulted in success. By a new process of differential flotation, it became possible to separate the complex ore into high grade lead concentrate and high grade zinc concentrate for treatment at Trail, and an iron concentrate to be impounded for future use. The first commercial application of this discovery was achieved in a test mill at Trail in the spring of 1920. The development unlocked the enormous possibilities of the Sullivan Mine and paved the way for Cominco's rapid growth.

Increasing quantities of Sullivan ore were treated by flotation at Trail until, in 1923, the 3,000-ton Sullivan Concentrator was completed near the Sullivan Mine at Kimberley. The output of the concentrator has been steadily increased to its present 11,000 tons per day capacity. Metallurgical operations at Trail were expanded rapidly. By 1929 Cominco was one of the world's largest producers of lead and zinc.

The growth of metallurgical operations resulted in the emission of ever-increasing quantities of sulphur-bearing smoke from the treatment of lead and zinc concentrates. Apart from the economic waste of a valuable chemical, the nearness of the plants to the international border and prevailing down-river winds caused some smoke damage to vegetation in the United States. As the result of complaints, an International Tribunal was established to consider the problem. In due course, Cominco was assessed certain damages and required to control the smoke. A large chemical fertilizer plant construction program at Trail was undertaken in 1930, based mainly on sulphuric acid produced from metallurgical smoke, and power from the Kootenay River. This was Cominco's entry into chemical production, now a major aspect of the Company's activity. In two respects it was a pioneering venture: the market for this relatively new product was very limited; also, it was an early example of eliminating serious atmospheric pollution.

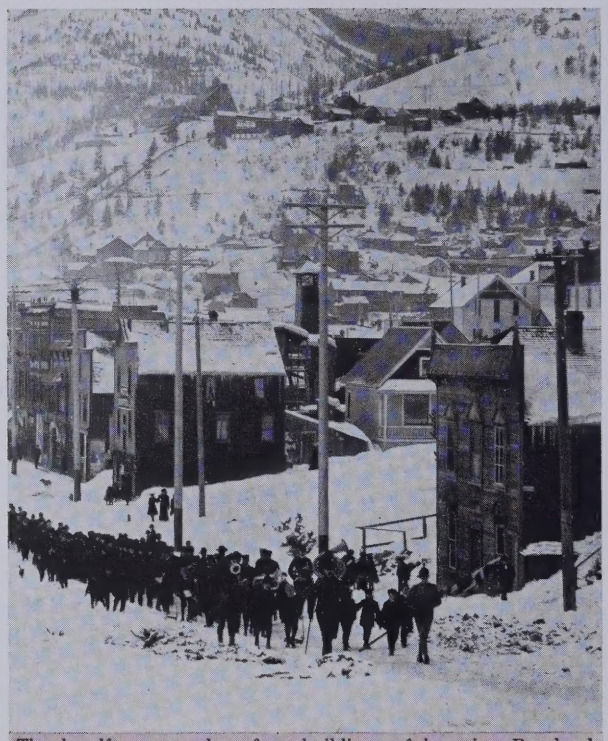


Forerunner of five major power plants on the Kootenay River, the original Lower Bonnington went into operation in 1898. The longest high voltage line on the continent linked it with Rossland and Trail.

Before metallurgical magic solved the problem of Sullivan Mine ore separation, early day employees sorted the ore by hand. Fragments rich in lead and silver were sent to the smelter. The rest was discarded.

The West Kootenay Power and Light Company, which had been formed in 1897, supplied power to the early Rossland and Trail operations from relatively small hydro-electric power plants on the Kootenay River some 35 miles from Trail. In 1916 Cominco acquired controlling interest in the power company and then proceeded to expand its operations. A long-range program was undertaken which has resulted in the full development of the Kootenay River power potential between Kootenay Lake and the Columbia River. This program provided for the metallurgical expansion, and later, for the requirements of the chemical fertilizer industry. Present installed capacity on the Kootenay River amounts to 389,000 h.p.

Cominco became interested in mining possibilities in the Northwest Territories shortly after World War I. Early Company prospecting parties covered considerable territory overland, and by canoe along the waterways. In the 1930's a fleet of Company aircraft, often piloted by mining engineers, greatly advanced exploration in Canada's North. Two important developments emerged. In 1938 the Company brought



The headframes and surface buildings of booming Rossland mines look down on a winter carnival parade in the young community. Today, the mine sites are marked only by old waste dumps, but the city flourishes.

the Con Mine at Yellowknife, N.W.T. into operation. The Con was one of the early gold mining developments in the North and ore production has increased steadily from 100 tons daily to the 475-ton daily rate of today. Also, the Company's majority interest in the substantial Pine Point lead-zinc property originated with the early prospecting program.

When war was declared in 1939, the chemical industry at Trail had become well established. At the request of the Government, the Ammonia Plant was expanded and new plants were built for the Government at Trail and Calgary. These were operated by Cominco under mangement contracts during the war years and acquired by the Company after the end of hostilities. Both the metallurgical and chemical fertilizer operations produced much material vital to the successful prosecution of the war.

Important quantities of mercury and tungsten came from Company mines during wartime. These were closed at the end of hostilities. The extraction of tin from Sullivan ore was commenced in 1941.

Following the war, the Company undertook an expansion program at a cost of more than $100,000,000.

The major items were:

1. Construction of an underground crushing plant at the Sullivan Mine, a four mile haulageway from the underground crushing plant to the concentrator, a sink-float plant at the concentrator, and a new main shaft to the lower levels of the mine; all completed in 1949 and costing $6,500,000.
2. Preparation for production of the Bluebell Mine at Riondel, B.C., the Tulsequah mines at Tulsequah, B.C., and the H.B. Mine at Salmo, B.C., including the construction of concentrators and surface facilities, at a cost of $7,500,000. Production commenced at Tulsequah in 1951 (and was suspended in 1957), at the Bluebell in 1952, and at the H.B. in 1955.
3. A program to modernize the Trail Lead Smelter, at a cost of $15,000,000.
4. A 66-ton per day expansion of production facilities at the Trail Zinc Plant, completed in 1953 and costing $3,000,000.
5. Construction of a fertilizer plant at Kimberley with an annual capacity of 70,000 tons of ammonium phosphate, completed in 1953 and costing $11,000,000.
6. Construction of an 86-mile transmission line from the Kootenay River power plants to supply the Kimberley and Riondel operations, completed in 1953 and costing $4,200,000.
7. Construction of the Waneta Power Plant on the Pend-d'Oreille River at its confluence with the Columbia about 11 miles south of Trail, completed in 1954 and costing $35,000,000.

The 1950's saw the completion of the post-war expansion and modernization program and particularly in the last half of the decade, changes in the market for Company products. The prices for lead and zinc dropped to critically low levels, and the fertilizer market became increasingly competitive. However, the Company was able to maintain its leading position through its strength, and through vigorous sales and research programs.

In 1956 Cominco formed Cominco Products, Inc. at Spokane, Washington, with a 50,000-ton dry fertilizer storage plant and liquid conversion and storage facilities. This company is responsible for the distribution of Elephant Brand fertilizers and other products in the United States.

In 1959 Cominco made three announcements which have expanded and further diversified production:

1. Construction of an Iron and Steel Smelter at Kimberley, at a cost which will exceed $20,000,000 (see page 17).
2. Construction of a 100 ton per day Urea Plant at Calgary, at a cost of $5,000,000.
3. Construction of a $2,600,000 Chlor-Alkali Plant at Trail.

Also in 1959, Cominco announced the purchase of National Hardware Specialties Limited, a die casting plant at Dresden, Ontario and, early in 1960, the purchase of Lustre Corporation of Canada, Limited at Wallaceburg, Ontario.

While many factors have contributed to the growth of Cominco, its programs of mining, exploration, research and sales development have been outstanding and are reflected in every phase of activity. In addition, throughout its 50 years of operation, Cominco has been served well by people: the men who conceived the Company and guided it toward its objectives of stability and steady progress; the executives and leaders who translated policy into production; the technical men who overcame complex problems and who contributed new and important ideas, and the men on the job who gave good service with faith and loyalty.

Exploration

THE search for new mining properties and their development are responsibilities of Cominco's Exploration Division. This work is carried out in Canada and, to a lesser extent, in the United States and foreign countries.

Prospecting, property examinations and geological studies of favourable areas provide projects for surface exploration. Some properties warrant preliminary surface development such as geological and geophysical work, and diamond drilling. If this offers encouragement, underground development is undertaken to confirm or extend the indicated ore tonnage.

Of the many properties explored, only a few reach the underground development stage. However, in recent years Cominco has carried out such work on the Pine Point lead-zinc property in the Northwest Territories, the Duncan lead-zinc property in the Lardeau district of British Columbia, and the Wedge copper property in New Brunswick.

The Head Office of the Exploration Division is at Trail. Branch offices are maintained at Montreal and Port Arthur. Field engineers and geologists may, however, be based temporarily in any area.

Cominco is interested in all types of mineral deposits. Exploration personnel carefully assess all properties at the request of independent prospectors or others to determine whether further work is warranted. Requests to examine mineral showings are welcomed at any of the Exploration offices.

A Cominco prospector stakes a mineral claim in southeastern British Columbia. Large numbers of claims must be located, examined and developed since very few have the potential to becoming producing mines.

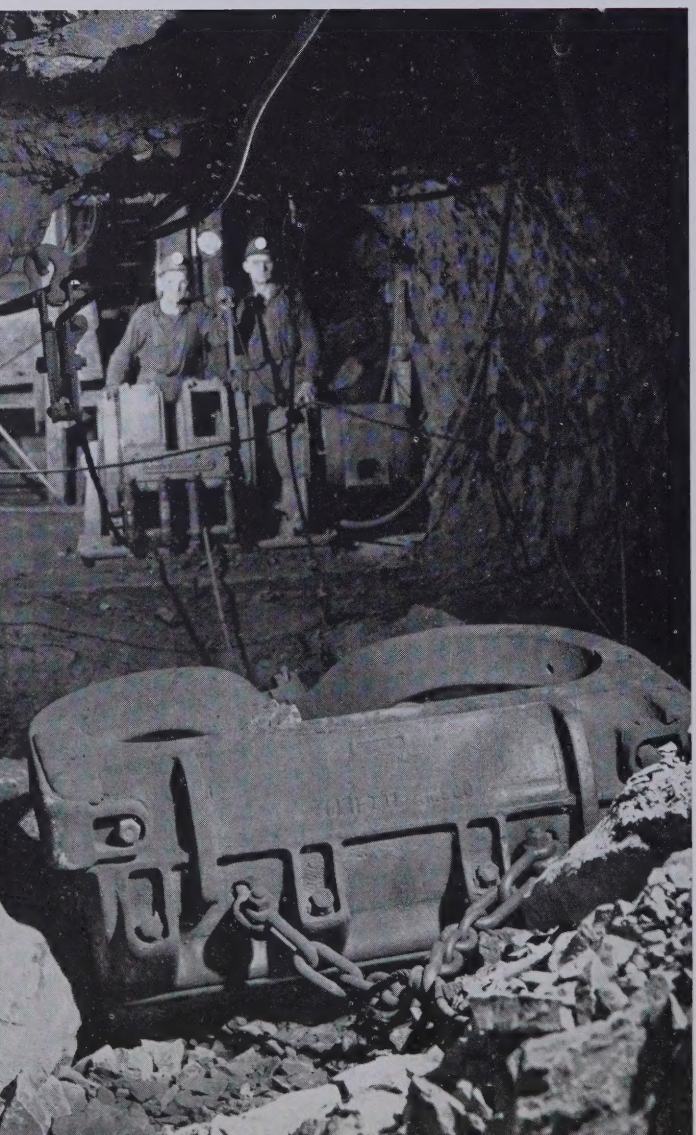
Interested in Mineral Deposits

Drill cores filling hundreds of boxes help tell the story of the Pine Point lead-zinc orebody to an Exploration employee. Mining will start at this Northwest Territories site when rail transportation is available.

Mining and Concentration

Main Source of Raw Materials

ORES and concentrates from a number of mining properties are the principal raw materials for Cominco's metallurgical, chemical and fertilizer operations. The responsibility for mining and concentration rests with the Mines Division.



The Sullivan Mine

Largest of its Kind

The Sullivan Mine at Kimberley, B.C., employing about 900 men, has one of the largest lead-zinc orebodies in the world. The deposit is a sulphide replacement in quartzites. The main minerals are lead, zinc and iron sulphides with an appreciable quantity of silver associated chiefly with the lead sulphide. The dip of the vein is generally to the east, averages about 17 degrees above the 3900-level* and about 39 degrees from the 3900 to the 3350-level. Below the 3350-level it gradually flattens to about 10 degrees. The orebody varies in thickness from five to 300 feet. Except for isolated iron zones, it is mined down the dip for 5,000 feet below the outcrop and along the strike for 5,000 feet.

* Operating levels of the mine are expressed in feet above sea level.

The main adit is the 3900-level tunnel. It extends 6,000 feet into the hillside to reach the orebody. Through this tunnel men and supplies enter the mine. The 3700-level tunnel extends 11,600 feet into the mine, making up half of the four mile haulageway over which ore is trammed to the Sullivan Concentrator.

Until 1939 all the ore came from above the 3900-level. Mining by open stopes was standard. These large cavities were separated by pillars left at fairly regular intervals to support the roof. In 1940 stoping was started below the 3900-level and, in 1951, production began from an open pit near the spot where ore was first found on the surface. At present, production

Miners in the Sullivan Mine operate a slusher, moving broken ore from a stope. The Sullivan has yielded about 79 million tons of ore and present production averages 10,000 tons per operating day.

Surface buildings at Cominco's Sullivan Mine, Kimberley, B.C. A total of 900 employees work on the surface and underground. The deposit, a sulphide replacement in quartzites, is one of the largest lead-zinc ore bodies in the world.

The Sullivan Concentrator, in the middle background, is flanked at right by an iron concentrate holding pond. The Iron and Steel project site is on forested land at centre. Foreground plants are the Kimberley Fertilizer Department.

is from pillars of ore above the 3900-level and from stopes and pillars below the 3900-level.

Filling is Important

Filling mined out areas to support the backs of stopes and to facilitate mining of the ore pillars is an important phase of the operation. An extensive filling program was started in 1935 using gravel from the surface. Steep raises were driven from the stopes to the surface and trucked gravel was dumped down them. About seven and a half million cubic yards of gravel fill have been placed to date in stopes above the 3900-level.

Stopes below the 3900-level are now being filled with waste rock or "float" from the Sullivan Concentrator. This is mixed with a small percentage of iron sulphide concentrate. The mixture oxidizes and cements into a solid mass, providing support for the backs of the stopes. Over two million cubic yards of this type of fill have been placed in stopes to date.

Mining Methods

Above the 3900-level most of the ore is mined from pillars surrounded by fill or caved waste. Generally the large pillars are recovered by blast hole diamond drilling. The largest pillar blast to date used 57 tons of explosives and broke 1,062,000 tons of ore.

Below the 3900-level, the ore is divided into alternating stoping and pillar blocks. Ore in the stoping blocks is mined by drilling long diamond drill holes from sub-levels or raises in the ore. The holes are charged with explosive and large slices of ore are broken with each blast. This permits the preparation of a large reserve of developed ore for breaking, and it is also a safer method. Pillar mining below the 3900-level started in 1959 and is similar to that used elsewhere in the mine.

An open pit operation, suspended temporarily in 1957, is located at the southern extremity of the orebody.

Tramming and Conveyors

All ore mined above the 3900-level is drawn from raises on this level and trammed to the 3800-level crushing chamber. Here is is crushed in jaw and cone crushers, loaded into cars and transported to the concentrator.

Ore mined below the 3900-level is trammed to ore passes leading to the 2850-level crushing chamber where it receives a primary crushing. From here it travels on a 4,200-foot system of belt conveyors to the 3800-level crushing chamber for further crushing and transportation to the concentrator.

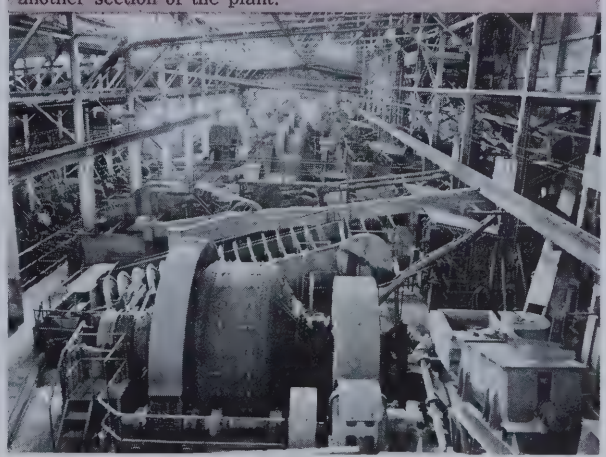
The average production of ore is 10,000 tons per operating day. By the end of 1959, a total of 79 million tons had been produced at the Sullivan Mine.

Ventilation and Services

Ten exhaust fans draw 885,000 cubic feet of air per minute from the Sullivan Mine, ensuring adequate ventilation. Blasting, other than daily development blasting, is done at night to allow several hours of dust and fume removal before the morning shift arrives.

All new employees attend a school to learn their jobs and the details and importance of safe working

Ball mills in the Sullivan Concentrator pulverize ore to the fineness of cement. Pulp, a mixture of this finely ground ore and water, is then ready for flotation machine treatment in another section of the plant.



Surface facilities at the Bluebell Mine, Riondel, B.C., include the headframe at right and the concentrator. The darker foreground buildings are shops and service units. Daily ore capacity is 700 tons. About 300 are employed.

Chemicals added to pulverized ore cause first the lead mineral and later the zinc mineral to float to the surface as froths. A Kimberley employee samples the froth from a flotation machine in the Sullivan Concentrator.

practices. The mine is inspected daily for safety in working conditions and practices.

Drilling equipment is operated by compressed air piped through the mine. Water operating in conjunction with the drills reduces dust from this source. Nearly all normal repair work is done underground in well-lighted shops located at various points.

The Sullivan Concentrator

Processes Complex Ore

The Sullivan Concentrator, at Chapman Camp near Kimberley, processes ore from the Sullivan Mine to yield products suitable for treatment in Cominco's metallurgical plants. The two major products, lead concentrate and zinc concentrate, are shipped to Trail by rail for extraction of the metal content and recovery of sulphur. An iron concentrate is also made. Some is used as a source of sulphur for sulphuric acid manufacture at the Kimberley Fertilizer Department.

Preparing for a blast which will extend the length of the drift or tunnel, Bluebell Mine employees wire explosive charges in drill holes at the drift face. Broken rock resulting from the blast will be mucked out by the next shift.

The remainder represents material which can be processed at the new Iron and Steel Plant nearby.

Sullivan Mine ore is highly complex and consists of three main metallic minerals: galena (lead sulphide), marmatite (zinc iron sulphide), pyrrhotite (iron sulphide), and various siliceous minerals which make up the waste rock. The ore also contains silver in several forms, cassiterite (tin oxide) and the sulphides or oxides of several other metals such as cadmium, indium, etc., as minor constituents. The crystal structure is so small and intermixed that, even after grinding to the fineness of cement, some particles still contain a mixture of different kinds of metallic minerals and rock.

Barren Rock Eliminated

The first step in concentration is elimination of about half the barren rock by the sink-float method. Ore is first screened and thoroughly washed with water sprays. The fine material bypasses the Sink and Float Plant. The coarse portion, one and a half down to one quarter inch in size, is fed to the sink-float separators. In these, a thick slurry of finely crushed galena and water causes the lighter waste rock to float while the heavier rock containing the valuable minerals sinks. After sink-float separation, both products are washed to recover the heavy medium. Part of the "float" is sent back to the mine for backfill. The "sink" and the previously separated "fines" are mixed with water and ground until at least 80% will pass through a screen with 200 openings to the inch.

The first stage of grinding takes place in a large rod mill, 11 feet 5 inches by 12 feet long. This is followed by three more stages in 16 ball mills which operate in conjunction with classifiers.

Concentrates Formed

The "pulp", as the mixture of finely ground ore and water is called, is fed to a series of flotation machines. As it passes through successive banks of machines, carefully adjusted amounts of chemicals are added. These cause first the lead mineral and later the zinc mineral to float to the surface as froths. The separate froths are thickened and filtered, forming lead

concentrate containing 65% lead and zinc concentrate containing 48% zinc.

The silver, an important constituent of the ore, is found principally in the lead concentrate which assays about 16 ounces of silver per ton.

The tailing product from the lead-zinc flotation phase contains 35% to 40% iron, a small amount of tin and most of the siliceous waste. The iron is separated by a further flotation step.

Tailings from the iron flotation are passed over tilting concentrators and shaking tables to yield about a ton per day of 60% metallic tin concentrate.

The Sullivan Concentrator is operated five days a week and shut down on weekends. During the five days, 50,000 tons of ore are treated to produce some 3,000 tons of lead concentrate and 4,000 tons of zinc concentrate.

Other Major Mines

The Con Mine

The Con Mine at Yellowknife, N.W.T., was staked by Company prospectors in 1935. It was brought production in 1938. The mine was equipped with a 100-ton mill which has been gradually increased in capacity to 500 tons daily. The gold recovery process consists essentially of amalgamation and cyanidation, followed by flotation, roasting of flotation concentrate and cyanidation of the calcine.

This operation has been continuous except for a three-year shutdown during World War II. The 2,000th gold bar was poured in 1959. About 225 are employed.

The Bluebell Mine

Following the discovery of new orebodies, the Bluebell Mine, an historic lead-zinc producer at scenic Riondel, B.C., on the east shore of Kootenay Lake, was rehabilitated and put into production during 1952. A new 700 ton per day mill was constructed to make lead concentrate and zinc concentrate from the ore. These are shipped to Trail for treatment. Where Indians smelted crude musket bullets over 100 years ago, an attractive mining community of nearly 300 employees and their families is well established.

Surveyors ready their equipment at the Con Mine, Yellowknife, Northwest Territories. A gold producer, the Con was staked as a pioneer Northland venture in 1935. In 1959, the 2,000th gold bar was poured at the modern mill.

The H.B. Mine

At the H.B. Mine, another early mining property located near Salmo, B.C., extensive exploration indicated a large zinc-lead orebody. A 1,200 ton per day mill was constructed and the property went into production in 1955. The ore is concentrated by flotation and concentrates are shipped to Trail for treatment. About 125 are employed.

The Fairview Mine

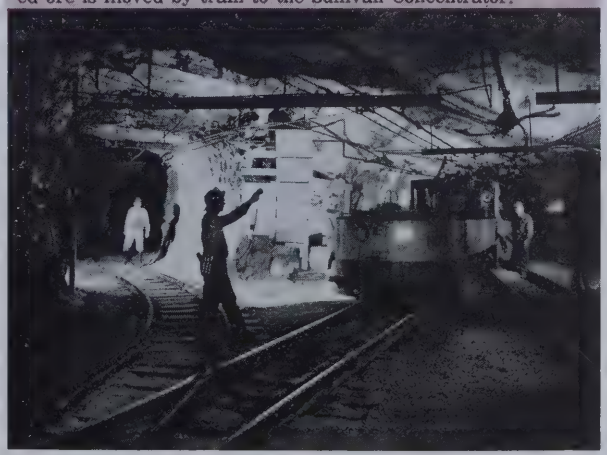
The Fairview Mine near Oliver, B.C., is operated as a source of siliceous flux for Lead Smelter operations. About 100 tons of flux per day are shipped to Trail.

The Phosphate Mines

Phosphate rock for the fertilizer operations at Trail and Kimberley is obtained from the mines of a subsidiary company in Montana. The total requirement for phosphate rock averages about 1,100 tons per day.

Diamond drilling in the H. B. Mine, Salmo, B.C. Large tonnages of ore are broken by drilling "rounds" of holes, charging them with explosives and blasting into a stope or underground chamber. Preparation for a blast may take months.

Tramming is an essential service in the huge Sullivan Mine. Men and equipment ride trains to reach work areas. Ore is trammed to conveying or crushing machinery. Finally, crushed ore is moved by train to the Sullivan Concentrator.



Smelting and Refining

Centred at Trail

ALL of Cominco's metallurgical operations are grouped for administrative purposes in one unit, the Metallurgical Division, with operations centred at Trail, B.C. These include the Lead Smelting Department, the Refining Department and the Zinc Department. In addition, the Division operates the Company's analytical laboratories and metal fabrication facilities.

Transfer pots in a Lead Smelter craneway. As much as 700 tons of lead bullion have been produced daily at Trail. Blast furnace slag is carried in the pots to the Slag Fuming Plant for further treatment.

Lead Smelting Department

The Lead Smelter treats Cominco lead concentrates, purchased lead concentrates and ores, Zinc Department residues and other plant products. End products are lead bullion for the Refinery, zinc oxide fume for treatment in the Zinc Department, and copper matte. A dilute sulphur dioxide gas is also produced for treatment in the Absorption Plant.

While the capacity of the Smelter varies with the proportions of materials treated, as much as 700 tons of lead bullion have been produced daily. Concentrates and ores normally account for 30% to 40% of treated tonnage. Zinc Department residues and limerock, siliceous and iron fluxes make up the balance.

All incoming materials are sampled and analyzed. Flux is proportioned to the lead and zinc bearing materials to form the proper blast furnace slag. The charge is then mixed, dried and sintered. Sintering eliminates sulphur and agglomerates the charge into a cinder-like product suitable for blast furnace reduction with coke. The sinter is smelted in blast furnaces for separation of bullion and slag, and the bullion is drossed and cast into anodes. Finally, the blast furnace slag is treated.

Sinter Plant

The Sinter Plant charge, as mixed, contains 18% to 20% moisture. Before sintering, this is dried to 8.5% moisture in three 10-foot by 80-foot dryers fired by natural gas. There are three sintering machines, each with 10 feet by 60 feet of windbox area. Normally two of these operate in parallel on a single-pass circuit.

A gas flame is used to ignite the sulphur in the

charge on the sintering machine. It burns to sulphur dioxide as fans draw air downward through the sinter bed. The sulphur is thus reduced from 9% to 1.5%. The gas is cleaned in a precipitator and its sulphur content recovered in an Absorption Plant.

Blast Furnaces

The finished sinter, to which has been added about 10.5% coke, is the feed for the lead blast furnaces. There are four of these, varying in length up to 22½ feet. Shaft heights are all 17 feet. Compressed air supplied through tuyeres burns the coke. This melts the charge and at the same time reduces the lead oxide to metallic lead.

Molten lead containing certain metallic impurities collects at the bottom of the furnaces and overflows to a transfer pot. Molten slag floats on top of the lead and is tapped off at a higher level for treatment in the slag fuming furnaces.

Blast furnace gases are cooled by sprays in a tower, passed through a baghouse which removes 99.9% of fume and dust, and then to the stack.

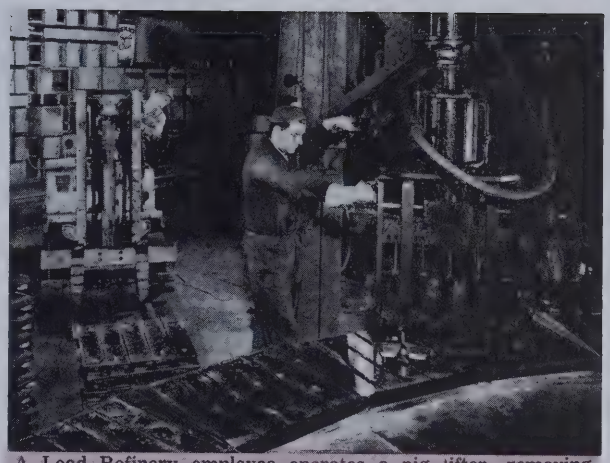
Drossing Plant

The bullion from the blast furnaces is about 98% lead. It also contains gold, silver, arsenic, antimony, copper, bismuth, indium and tin. It is charged to a 100-ton reverberatory furnace in the Drossing Plant. Here the temperature of the metal is allowed to fall below 1,000° F. and some of the impurities rise to the surface as a dross which is skimmed off. This is treated to produce a copper-lead matte for sale, and a lead-tin-indium slag for further treatment.

The lead bullion, still containing the silver and gold and minor amounts of other metals, is cast into anode plates suitable for electrolytic refining.

Slag Fuming Plant

The Slag Fuming Plant recovers zinc and lead from blast furnace slag. It consists of two furnaces and waste heat boilers. Each furnace is 10 feet wide, 24 feet long, 10 feet high and completely water jacketed.



A Lead Refinery employee operates a pig lifter, removing 100-pound lead pigs from a casting wheel. The pigs are then carried by fork lift truck to weigh scales and may be loaded into boxcars for shipment or held in storage.

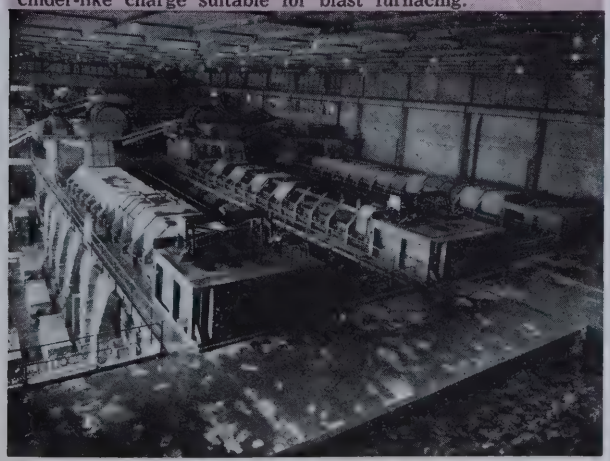
Molten slag is poured into the furnaces, a complete charge being about 50 tons. Six tons per hour of powdered coal are blown into the charge with air through tuyeres. The charge cycle varies from 180 to 200 minutes.

Gases from the slag fuming furnaces, carrying zinc and lead as white oxide dust, pass through boilers and economizers to a baghouse where the dust is collected. This goes to the Zinc Plant for zinc recovery. The lead content is separated as lead sulphate residue which returns to the Smelter.

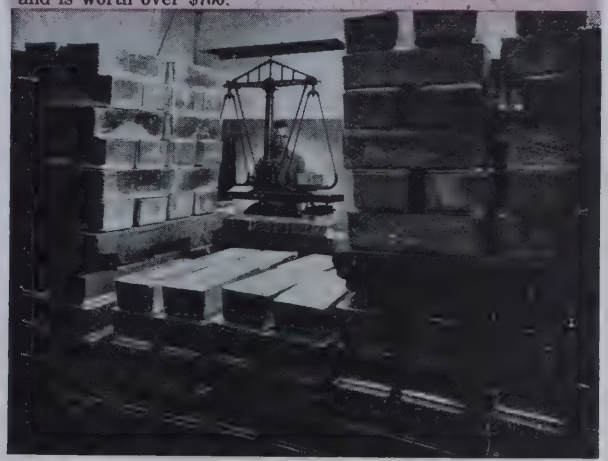
Refining Department

In the Lead Refinery, bullion anodes from the Lead Smelter are placed in electrolytic cells. An electric current causes lead from the anodes to dissolve and be plated in a pure form on cathode starting sheets. The cathode metal is melted, further purified by drossing, then cast into lead pigs for market.

Feed preparation equipment at the Lead Smelter includes three sintering machines, each with 10 feet by 60 feet of windbox area. Sintering eliminates sulphur and produces a cinder-like charge suitable for blast furnacing.



Refined silver, an important byproduct of the lead refining process, frames a Silver Refinery employee as he weighs one of the bars. Each bar tips the scales at about 1,000 ounces and is worth over $700.



Representative Analyses of Bullion and Refined Lead

	Gold oz. per ton	Silver oz. per ton	Copper %	Lead %	Antimony %	Arsenic %	Tin %	Bismuth %
Lead Bullion	0.125	73.8	0.05	98.09	1.02	0.48	0.002	0.11
Refined Lead	<.0003	0.08	0.0002	99.997	0.0001	0.00008	trace	0.0008

This plant is the world's pioneer electrolytic lead refinery. Operations started in 1902. By 1922 a capacity of 100 tons per day had been attained. Additions between 1922 and 1926 brought capacity up to 400 tons per day. Since then about 25% of the cells have been removed, but improvements in metallurgical practice have made possible the present daily capacity of 450 tons.

Bullion from the Smelter is unloaded directly into Refinery cells. The electrolyte used is a solution of lead silico-fluoride and hydrofluosilicic acid. It is circulated through the cells by centrifugal pumps.

The anodes are in the cells for seven days, after which both anodes and cathodes are removed. The cathode lead is melted at a temperature of 950° F. in 235-ton, welded steel, natural gas fired kettles. It is then blown with air to remove small percentages of tin, arsenic and antimony. Cooled to 800° F., it is finally cast into pigs of Tadanac Brand lead for market.

During electrolysis, the impurities and other metals in the lead bullion remain on the anodes as mud. This is removed by motor-driven brushes and washed free of electrolyte at the end of the seven day period. Anodes lose about 70% of their weight. The remainder is melted and recast into new anodes.

Silver and Gold

Anode mud from the Lead Refinery is treated to recover gold, silver, bismuth and antimony. The processes, essentially furnace treatments:

(1) melt the anode mud to metal and slag;

(2) eliminate arsenic and antimony from the metal as fume;

(3) cupellate the metal to a gold-silver alloy;

(4) reduce the cupellation slag to a lead-bismuth metal plus some slag.

Slags from (1) and (4) are returned to the Lead Smelter.

The gold and silver from (3) are separated by electrolysis in a silver nitrate solution. The silver is melted and cast into 1,000 troy ounce bars for market. Average purity is 999.7 fine (99.97% pure). Capacity of the Silver Refinery is 15,000,000 ounces per year. The gold, approximately 975 fine, is shipped to the Canadian Mint.

Bismuth

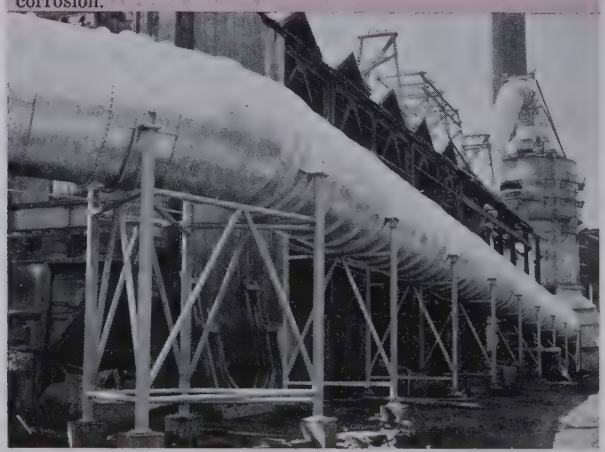
The lead-bismuth from (4) is drossed for removal of copper. The precious metals are then removed by the Parkes process. Residual metal is refined electrolytically by the Betts process. The anode mud from this operation is melted and refined to bismuth of 99.99+% purity.

Antimonial Lead

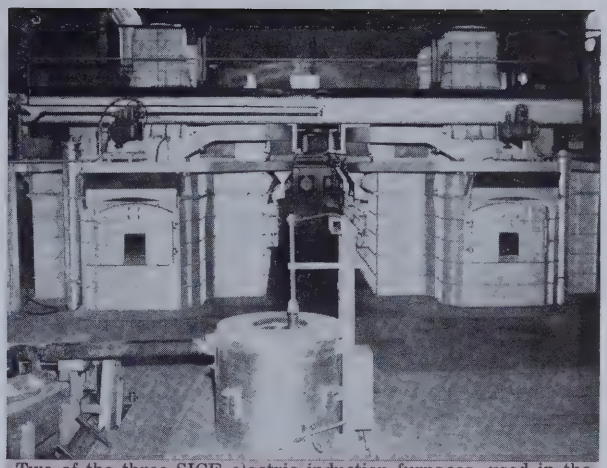
Drosses from the fire refining of cathode lead are mixed with fume from silver refining (2). This mix is reduced with coal to produce antimonial lead containing some arsenic which is removed with caustic soda. The resultant metal is cast into bars of antimonial lead.

Electrolytic lead refining takes place in rows of cells which have a total capacity of 450 tons per day. Cominco began operation of the world's pioneer electrolytic lead refinery in 1902. The modern plant is unique in Canada.

A lead-lined steel flue and cooling tower link the Lead Smelter Sintering Plant with a treater processing sulphur dioxide gas. About 200,000 pounds of lead protect this system from corrosion.



One of three tank rooms in the world's largest Zinc Plant at Trail. Pure zinc is plated out electrolytically from a zinc sulphate solution flowing through the cells. Pure zinc sheets appear at right.



Two of the three SICE electric induction furnaces, used in the Zinc Department's Melting Plant to melt pure zinc sheets from the electrolysis process. The furnaces feed slab casting machines.

Zinc Department

Cominco at Trail and the Anaconda Company at Great Falls, Montana, pioneered electrolytic zinc production on this continent during World War I.

The rated capacity of the Trail plant in 1916 was 60 tons of slab zinc per day. This has been increased gradually to 530 tons per day. Total production of slab zinc at Trail reached 5,000,000 tons in 1960.

While operational details vary in electrolytic zinc plants, all produce the metal from a solution of zinc sulphate by electrolysis. At Trail, the four process steps are: roasting; leaching and purification; electrolysis; melting.

Roasting

The main feed to the Zinc Department is zinc concentrate from the Sullivan Concentrator. The mineral is in the form of a zinc-iron sulphide. Other Cominco mines also supply zinc concentrate, and some is purchased for treatment.

Roasting converts the zinc sulphide to zinc oxide which is dissolved in dilute sulphuric acid. The iron is converted to insoluble ferric oxide. The sulphur is discharged as sulphur dioxide gas at a concentration suitable for sulphuric acid manufacture.

Originally, roasting was done in 25 standard Wedge furnaces, each with a daily capacity of 35 tons. Fuel was needed to maintain the operating temperature.

A new method of suspension roasting was developed at Trail and has been used exclusively since 1931. Eight converted furnaces now operate at any rate of feed between 100 and 180 tons per day. No fuel is needed and by-product steam is produced.

Leaching and Purification

Roasted zinc concentrate is delivered continuously to the Leaching Plant. Here it is treated with dilute sulphuric acid to dissolve the zinc oxide. This gives an impure zinc sulphate solution containing cadmium, copper and various other minor impurities originally present in the concentrate. The solution is then purified to produce a pure zinc sulphate solution for electrolysis. Residues contain values which are recovered; cadmium in the Zinc Department, and a residue containing gold, silver and lead together with some remaining zinc goes to the Lead Smelter for retreatment.

Electrolysis

The purified zinc sulphate solution is delivered to the electrolytic tank rooms. Tanks are arranged in 65 units. Each unit is made up of four cascades

Representative Analysis of Roasted Zinc Concentrate

Lead %	Zinc %	Iron %	Total Sulphur %	Sulphate Sulphur %
7.4	55.4	11.0	2.3	1.7

Zinc sheets from the tank rooms are melted by electric induction and cast into 56-pound slabs for market. A fork lift truck operator stacks slabs in the Melting Plant storage area, conveniently near a railside loading ramp.

Analyses of Slab Zinc Standard Grades

	Lead %	Cadmium %	Iron %	Copper %	Zinc %
Special High Grade	.0017	.001	.001	.001	99.99+
High Grade	.007	.002	.001	.001	99.95
Prime Western	1.00	.007	.001	.001	98.50

Various modifications of these grades are supplied to meet special requirements.

of nine cells each. Cells are concrete with acid-proof linings.

Lead alloy anodes (0.75% silver) are used. The zinc is deposited on aluminum cathodes and stripped off every 24 hours. Electrolysis regenerates sulphuric acid which is returned to the leaching section.

Direct current for electrolysis is supplied by seven motor generator sets, ten rotary converters, four mercury arc rectifiers and three ignitrons with a total capacity of 73,000 KW.

Melting

Zinc sheets from electrolysis are melted in three SICE electric induction furnaces and cast on four Sheppard casting machines into 56-pound slabs. Three standard grades of zinc are produced.

Cadmium

Most zinc ores contain minor amounts of cadmium. In the electrolytic zinc process, cadmium precipitated in the purification cycle is recovered later by electrolysis.

The market forms produced are sticks, bars, plates and balls.

Analytical Laboratories

The main analytical laboratories at Trail and the branches at various operations are responsible for the chemical control of processes. The main laboratory includes bucking, fire assay, wet chemicals and spectrographic sections. Equipment and facilities in all laboratories are among the most efficient and modern in the industry.

Metal Fabrication

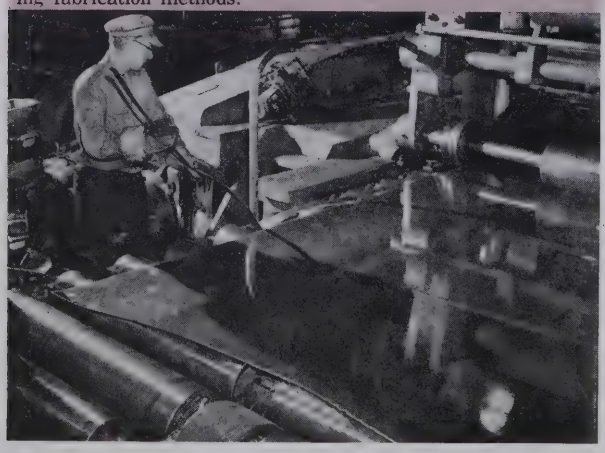
Recent developments in uses for Cominco metals, particularly zinc, prompted the establishment of a Metal Fabrication Plant at Trail. Extruded zinc strip for terrazzo flooring, and zinc shapes for the cathodic protection of submerged steel structures against corrosion are among its products. Testing fabrication methods on a plant scale for various potential metal products is also an important function.

Metallurgical Development

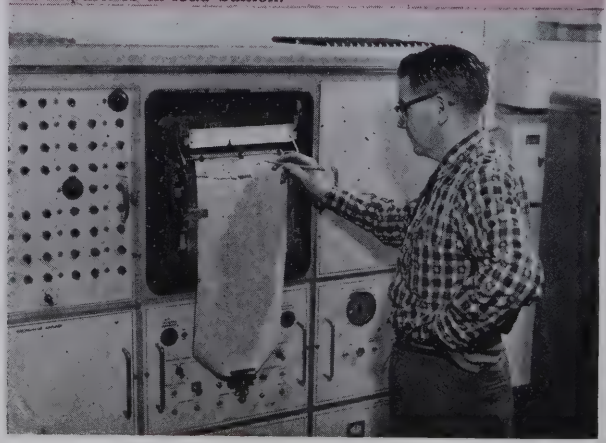
Metallurgical Development, with a staff of 20 technicians and development engineers, was reorganized to its present Departmental form 14 years ago. Its primary concern is with improvements in all of the metal plants. Development Engineers work closely with departments concerned to find ways of increasing efficiency either through better equipment, or improvements to existing production methods.

Some specific duties include the search for methods to improve the quality of products; methods to recover the maximum metal from ores; methods to lower the costs of production, and to act as troubleshooters to assist plant personnel in correcting deviations from normal operating performance.

Lead sheet leaves a Metal Fabrication Plant rolling mill. Established recently, the plant also produces a variety of fabricated zinc products and provides large-scale facilities for testing fabrication methods.



Cominco's analytical laboratories are responsible for chemical control of processes. A spectroscopist in the main laboratory at Trail is shown checking the results of a quantometer test on impurities in lead bullion.



Iron and Steel

COMINCO'S interest in iron and steel dates back many years, for iron is the largest single component of the Sullivan Mine orebody. However, production was not possible until markets in Western Canada developed sufficient strength, and this did not happen until recently. Through the years of dormant interest the stockpile of iron concentrate at Kimberley continued to grow. The first process research on this material commenced in 1948 at Trail, and early in 1949 a small amount of pig iron was made for test purposes. This was evaluated at Ottawa for steelmaking, and the results were favourable. In 1953 the Kimberley Fertilizer Department began operating. In utilizing iron concentrate to produce sulphuric acid, a stockpile of iron oxide was started.

As market research studies indicated approaching economic feasibility, technical work was accelerated. Experts in North America and Europe were consulted, and large-scale tests were undertaken in Europe in 1957. By the time market studies indicated sufficient sales potential, the basic technical research had been completed with the assurance of economic production of quality products. This resulted in the announcement of Cominco's iron and steel project in April, 1959, and the start-up of pig iron production in 1960.

The development plan called for the construction first of a Sintering and Feed Preparation Plant of 500 tons per day capacity, and an electrothermic pig iron Furnace Plant of 100 tons per day capacity. These units will be followed by a second, larger pig iron Furnace Plant, a steel conversion operation, and fabricating facilities. The project will cost more than $20,000,000 and produce over 100,000 tons of products annually.

The basic raw material for the iron and steel smelter is iron concentrate. At the start of iron production the concentrate storage area held 15,000,000 tons of recoverable iron. This is increased by over 350,000 tons per year from Sullivan mining operations. In addition, there is in the mine a very large tonnage of pyrrhotite which could be taken out for its iron content. Other raw materials include coke, obtained from the nearby Crowsnest Pass area, and hydro-electric power from the Company's developments in the Trail area.

At the start of the process, the Sullivan Concentrator produces a specially cleaned iron concentrate of 55% iron and 33% sulphur. The sulphur is removed by suspension roasters at the nearby fertilizer plants for sulphuric acid production, yielding iron oxide of about 65% iron content. This is delivered as a slurry to the Sintering and Feed Preparation Plant. Although it is fine—at least 50%-200 mesh, it is ground to 85%-325 mesh to be suitable for sintering. It is filtered to a moisture content of less than 12%, then together with return sinter fines, agglomerated to pellets of about 3/16-inch diameter by rolling on a large, rotating disc. Coke fines are added and the two components are mixed in a drum. On the strand sintering machine the ignited coke fuses the fine iron oxide to produce a strong, partially slagged sinter. Sintering temperature is about 2,100° F. After crushing and screening the sinter is ready for the reduction furnace.

The furnace feed is composed of mixed sinter, sized coke and sized dolomite flux. This is charged continuously into a submerged arc electric furnace. The furnace shell is 33 feet in diameter by 20 feet high. Power is transmitted through three electrodes of 3.5-foot diameter. The electrodes are buried in the charge, but the tips do not enter the molten bath below. In furnace operation about half the coke requirement of a standard blast furnace is replaced by electrical energy. Pig iron and slag are tapped every four to six hours. Iron averages about 4% carbon, and silicon can be varied between 1% and 2.5%, depending on market requirements. By-product gases are collected, cleaned, and used for fertilizer plant heating or for chemical processing.

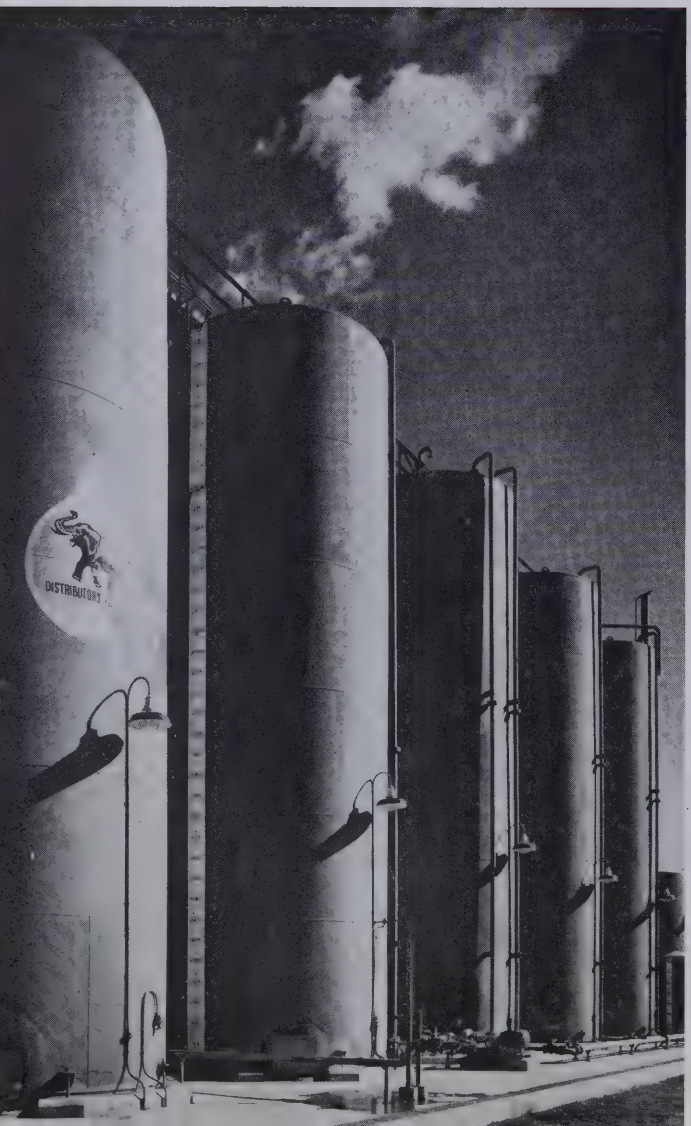
An oxygen process will be used for steel-making. Steel fabrications will probably be in two general ranges: all-purpose mill products, and flat rolled plate and sheet.

The new development is the first integrated iron and steel operation for Western Canada. It has been designed to produce products of the highest quality and for substantial expansion in keeping with the growth of the West.

The iron and steel project's Sintering and Feed Preparation Plant, shown under construction during the summer of 1960.

Chemicals and Fertilizers

A Major Canadian Industry



SULLIVAN Mine lead-zinc-iron-silver ore contains sulphur. As facilities at Trail for extracting metals gradually increased in size and scope, available sulphur in sulphur dioxide form also increased. By the early 1920's it became apparent that release of this gas to the air could not continue indefinitely and, due to sulphur's potential value, that recovery would soon have economic merit.

Some sulphur dioxide was useful in metallurgical processes. And although the rest could be made into sulphuric acid, the amount would have been far greater than the requirements of the market area. In 1926, after studies of the problem, a decision was made to use sulphuric acid as an intermediate product in chemical fertilizer manufacture. Then, in 1927, alleged smoke damage to farms in the adjacent State of Washington resulted in claims being made against the Company. The case was referred to an International Tribunal. As a result, Cominco was ordered to pay certain damages and observe strict control on the release of sulphur gases.

In 1929 the first sulphur dioxide recovery unit, a sulphuric acid plant of 35 tons daily capacity, went into operation at Trail. Three more plants, each of 112 tons daily capacity, were operating by 1930.

In 1930 a $10,000,000 fertilizer plant construction program was launched nearby. This provided for an ammonia unit consisting of an electrolytic hydrogen plant, a liquid air plant for nitrogen manufacture and an ammonia synthesis plant; phosphoric acid and phosphate fertilizer plants; an ammonium sulphate plant; storage, offices, shops and other facilities. Production began in the summer of 1931.

Elemental sulphur was also produced commercially at Trail between 1936 and 1943. This operation ceased when the demand for fertilizers had increased to a point requiring the use of all recoverable sulphur as sulphuric acid in their manufacture.

During World War II, Cominco operated ammonia, nitric acid and nitrate plants built for the Government at Trail and Calgary. Wartime needs saw expansion of its other chemical operations. In 1946 the Company purchased the two Government plants.

Completion of the Kimberley Fertilizer Department in 1953 as an ammonium phosphate producer, a Urea Plant at Calgary in 1960, and extensive plant additions over the years, have made Cominco, with its 700,000 ton annual output, one of the world's largest fertilizer producers and a major Canadian chemical company.

Liquid fertilizer storage tanks at Cominco Products Inc., symbolize the continuing growth of the industry. With its 700,000 ton per year output of fertilizers, Cominco is one of the world's largest producers.

The chemical and fertilizer plants at Trail began production in 1931. This was a significant step in the utilization of sulphur from Sullivan Mine ore. But the original plants were soon joined by others (below).

At Trail, B.C.

Sulphuric Acid

Sulphur dioxide from metallurgical operations is converted to sulphuric acid. Gases containing up to 7% sulphur dioxide are cleaned of dust by electrostatic precipitation and water washing. Gases high in sulphur dioxide content go directly to five standard contact sulphuric acid plants. Gases low in sulphur dioxide content are treated to absorb the sulphur dioxide which is regenerated in pure form. Some of this is then made into sulphuric acid in a plant using a cyclic process and the remainder "sweetens" the gases going to the other plants.

In the absorption process, aqueous ammonia absorbs sulphur dioxide. This step yields an ammonium bisulphite solution. Addition of sulphuric acid liberates almost pure sulphur dioxide and forms an ammonium sulphate solution. The solution is pumped to a separate plant for crystallization of this fertilizer.

To make sulphuric acid from the regenerated gas, pure sulphur dioxide and by-product oxygen are added continuously to a circulating load of inert gas and the sulphur dioxide is then converted to form sulphur trioxide in the presence of a vanadium oxide catalyst. This gas is absorbed and combined with water to obtain sulphuric acid.

In the five other plants, the process consists of drying the clean gas with sulphuric acid, oxidation of the sulphur dioxide to sulphur trioxide using a vanadium oxide catalyst, and absorption of the sulphur trioxide in 98.5% sulphuric acid. The final product is largely 93% acid obtained by dilution of the absorption acid.

The six plants have a capacity of 1,200 tons of sulphuric acid daily. Almost all is used in fertilizer production. One unit is also equipped to make oleum of any required strength. Solutions of aqua ammonia and sulphur dioxide as well as liquid sulphur dioxide are also produced for sale.

Ammonia

Ammonia, a combination of nitrogen and hydrogen, is an important ingredient in many fertilizers.

Nitrogen is produced in three liquid air units, each with a daily capacity of 46 tons. Hydrogen is produced by the electrolysis of water in 3,215 cells of local design. Direct current power is provided by three 10,000 ampere-670 volt and seven 10,000 ampere-830 volt mercury arc rectifiers. The electrolyte is a 28% caustic potash solution. Both the hydrogen and nitrogen produced are 99.9% pure.

In the Ammonia Plant, the nitrogen and hydrogen gases, mixed one to three by volume, are compressed to about 3,500 pounds per square inch in six-stage compressors. The gas mixture is then circulated through synthesis columns containing an iron-base catalyst self-maintained at a temperature of 400-500°C. In one passage through a column about 15% of the mixture is converted to ammonia. This is condensed to liquid in a cooling cycle, separating it from the residual gas which is recycled with a continuous addition of fresh mixture.

A natural gas reforming process is used in another plant to produce a gas mixture suitable for ammonia synthesis.

Part of the liquid ammonia is vaporized and used as a gas for fertilizer production. Some is sold in liquid form for use directly as a fertilizer. The rest is dissolved in water and used in the absorption of sulphur dioxide as already described.

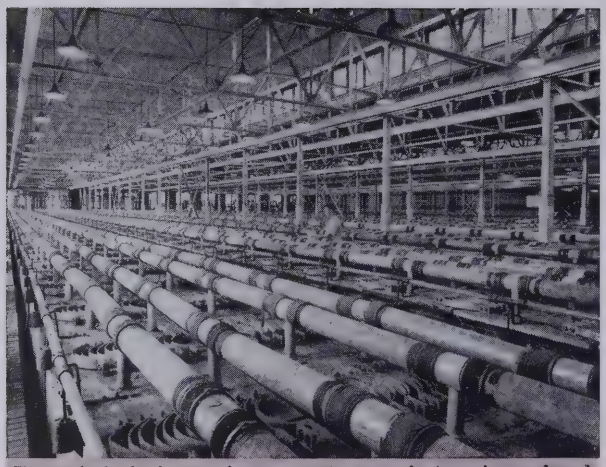
Ammonium Phosphate

Phosphate rock is the usual source of phosphorus in chemical fertilizers. If concentrated fertilizers are required, phosphoric acid must first be made from the rock.

In the acid section of the Phosphate Plant at Trail there are two units with a total capacity of 800 tons of phosphate rock per day. The continuous process consists of reacting ground rock with sulphuric acid in a series of tanks with mechanical agitators. This step is followed by filtration steps to separate phosphoric acid from a gypsum by-product. The acid contains 32% to 33% phosphorus pentoxide (P_2O_5).

The fertilizer section has three units with a total

Expansion at the Trail chemical and fertilizer operations is still very much a part of the present picture. In addition to the modern plants shown, a Chlor-Alkali Plant was built in 1960 keynoting diversification.



Electrolytic hydrogen for ammonia manufacture is produced at the Hydrogen Plant, Trail. The process, using a caustic potash electrolyte, yields a 99.9% pure product. Pipes for gas collection appear above the cells.

A Phosphate Plant employee at Trail checks the flow of crushed phosphate rock across automatic weighing equipment before it enters the phosphoric acid process. Ammoniation of the acid results in ammonium phosphate fertilizer.

finished product capacity of up to 900 tons per day. These can be used interchangeably to produce:

(a) ammonium phosphate containing 11% nitrogen and 48% P_2O_5, by neutralization of phosphoric acid with ammonia gas;
(b) ammonium phosphate-sulphate containing 16% nitrogen and 20% P_2O_5, by neutralization of a phosphoric acid - ammonium sulphate solution with ammonia gas.
(c) a range of other special fertilizer products.

The manufacturing method for all these fertilizers is basically the same. The slurry or mud resulting from ammoniation of the acid solutions is mixed with fine particles screened from the finished product and potash is added if required. The mixing action results in the formation of round, compact pellets or granules which are dried, sized by screening and stored.

Ammonium Sulphate

The Ammonium Sulphate Plant can manufacture this fertilizer either by direct neutralization of sulphuric acid with ammonia, or by evaporation and crystallization of the ammonium sulphate solution from the sulphuric acid plants. Direct neutralization is seldom used at present because all ammonia in excess of needs for sulphur dioxide recovery is used for making other fertilizers.

The plant has a capacity of 600 tons per day. It is equipped with crystallizers, centrifuges, dryers and conveying equipment. The process involves vacuum evaporation and crystallization, separation of the crystals from the ammonium sulphate liquor by centrifuging, and drying of the crystals. The final product is then sent to storage.

Ammonium Nitrate

Nitraprills is the Cominco trade name for ammonium nitrate fertilizer in specially pelletted form.

Nitric acid is made by oxidation of ammonia with air followed by absorption of the resulting gases in water. This acid is neutralized by ammonia to yield an ammonium nitrate solution which is concentrated by evaporation and prilled. Prilling produces compact, round pellets. Daily capacity of the Nitrate Plant is 370 tons.

Other Fertilizer Products

Cominco produces a wide range of dry and liquid chemical fertilizers, formulated to meet the varied needs of its major markets — Canada and the United States. A complete current list of Elephant Brand fertilizer products appears on page 35.

Storage and Shipping

Due to the seasonal demand for fertilizers, large storage space is necessary. The Storage Plant at Trail has a capacity of 100,000 tons. Various fertilizers are stored in bulk until required. Then, after additional screening, they are placed in paper bags or jute sacks and shipped to consumers. Large consignments of certain fertilizers may be shipped in bulk. Nitraprills are stored in bags in a special warehouse and shipped from it.

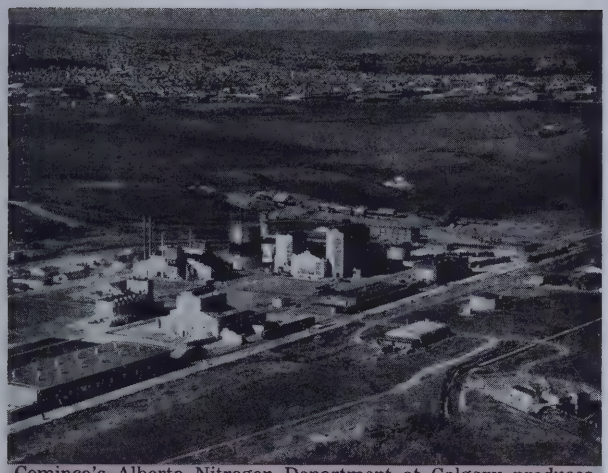
Liquid fertilizers are piped from process or storage facilities to roadside or railside loading areas depending on the method of transport.

Chlor-Alkali

The Chlor-Alkali Plant at Trail, built in 1960, is the most recent addition to Cominco's chemical operations. It produces liquid chlorine, caustic soda and caustic potash.

The process calls for sodium chloride or potassium chloride to be dissolved in water, forming brine. This is treated in electrolytic cells. Hydrogen and chlorine gases are generated and are collected separately, and caustic soda or caustic potash is formed. The by-product hydrogen is available for ammonia production. The chlorine, after cooling, drying and compressing, is ready for delivery to consumers. The caustic soda or potash is concentrated and excess chloride is removed before shipment.

Chlorine and caustic soda are required by the pulp and paper industry for bleached kraft pulp manufacture. Caustic potash or potassium hydroxide can be used by Cominco in its own operations.



Cominco's Alberta Nitrogen Department at Calgary produces ammonia, ammonium nitrate (Nitraprills) fertilizer and urea. Fertilizer applicators which fit all standard types of grain seed drills are also made at Calgary.

At Calgary, Alta.

Cominco's chemical plants at Calgary produce ammonia, ammonium nitrate (Nitraprills) and urea. Natural gas containing mostly methane is the major raw material. Burned in air, it produces nitrogen. In another section, more gas is reacted with steam to produce hydrogen.

Nitrogen and hydrogen are purified and converted to ammonia. Some ammonia is used at Calgary and, seasonally, substantial amounts are sold for use directly as a fertilizer. The balance is shipped to Trail or Kimberley.

The ammonia and ammonium nitrate (Nitraprills) processes at Calgary follow very closely the Trail processes already described. Calgary capacities are 320 tons of ammonia and 200 tons of Nitraprills daily.

The Urea Plant, completed in 1960, uses ammonia and carbon dioxide as raw materials. These gases are reacted under pressure to produce urea. Capacity is 100 tons per day. Uncombined ammonia and carbon dioxide can be recycled. The urea is prilled, cooled and conveyed to a 10,000-ton storage building. A nearby conditioning and packaging plant can handle 50 tons per hour.

Cominco-designed fertilizer applicators which fit all standard types of grain seed drills are made by the Company at Calgary.

At Kimberley, B.C.

The chemical fertilizer plants at Kimberley are designed to produce 270 tons of sulphuric acid per day by suspension roasting of iron concentrate from the nearby Sullivan Concentrator and conversion of the resulting sulphur dioxide to acid. Phosphate rock is treated with the sulphuric acid to produce phosphoric acid. This is neutralized by ammonia from Calgary. Output is about 200 tons of ammonium phosphate fertilizer daily.

A 35,000-ton bulk storage building and bagging and shipping facilities, shops, warehouse, office and dry serve the production units.

While much of the Company's solid fertilizer production goes to consumers in 80-pound paper bags, larger jute bags are also used for certain orders. Some export shipments are made in bulk at the customer's request.

A recent major addition to Cominco's list of fertilizer products is urea in both solid and liquid form. A prilling tower and Storage Plant for solid urea are among new additions to Alberta Nitrogen Department facilities.

Electric Power

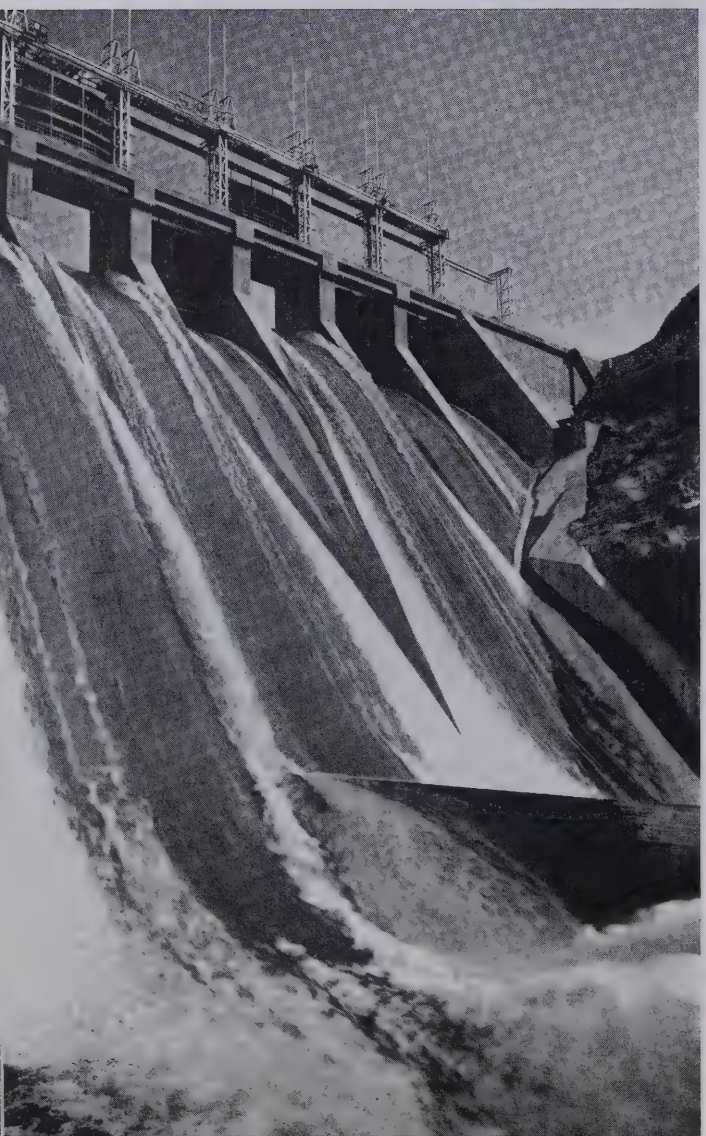
Enough for a City

COMINCO'S operations at Trail consume over 1¾ billion kilowatt hours of electric power per year—enough for a city of 650,000 people. Major processes requiring power are the electrolytic refining of zinc, lead and other metals, and the electrolytic production of hydrogen and chlorine. Other power applications include smoke treaters, evaporators, boilers, furnaces, pumping stations, plant motors, a narrow gauge railway and general lighting.

Power requirements at others points are comparatively less substantial. However, at Kimberley, B.C., development of the iron and steel project will increase consumption considerably.

Four Cominco power plants on the Kootenay River and one on the Pend-d'Oreille River supply the Company's operations in the Kootenays, including Trail. Their total rated capacity is 569,000 h.p. Another plant of 60,000 h.p., on the Kootenay River, is owned by the West Kootenay Power and Light Company, Limited and operates in conjunction with the Cominco plants.

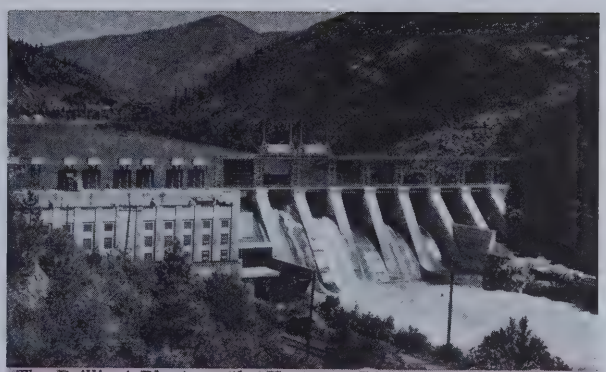
The Corra Linn Plant, of 57,000 h.p. capacity, is nine miles downstream from Nelson. This 14-gate plant is also used for controlling water storage in Kootenay Lake, an area of 180 square miles. It was



The Kootenay River to Kimberley transmission line crosses Kootenay Lake with a span two miles long. When it was built in 1952, the span was the longest in the world. A branch line serves Riondel operations.

Cominco's Waneta Power Plant, on the Pend-d'Oreille River near Trail, has an installed capacity of 240,000 h.p. and settings for an additional 240,000 h.p. It is the largest of five Cominco power plants in the area.

The Waneta Dam and Power Plant were built at a cost of $35,000,000. Transmission lines to Trail and a switching station there cost an additional $1,300,000. The first unit generated power early in 1954.



The Brilliant Plant, on the Kootenay River near its confluence with the Columbia, has a capacity of 111,000 h.p. and was completed in 1944. It is one of five plants utilizing a drop of 360 feet in the river's final 14 miles.

completed in 1932. The Upper Bonnington Plant of 86,000 h.p. capacity is situated one mile below. It was completed in 1907; the last extension in 1940. The West Kootenay Power and Light Company's plant at Lower Bonnington Falls is a mile downstream from the upper falls. The first hydro installation was there. The present plant of 60,000 h.p. capacity replaced the original plant in 1923. One mile below this plant the South Slocan Plant of 75,000 h.p. was completed in 1928. The Brilliant Plant is eleven miles below South Slocan. It has a capacity of 111,000 h.p. and was completed in 1944. These five plants utilize a drop of 360 feet in a 14-mile stretch of the Kootenay River. The Waneta plant of 240,000 installed h.p. is situated on the Pend-d'Oreille River one quarter mile from its confluence with the Columbia River. This plant was completed in 1954 with two units installed and provision made for an additional two units which, when installed, will increase the capacity to 480,000 h.p.

Power is transmitted to Trail at 60,000 volts, 3-phase, 60 cycles. Operations there are on a 24 hour basis and had a 289,000 h.p. average load in 1959. The chemical and fertilizer plants consume 54% of the power, zinc operations use 36% and all others use 10%. The installed capacity of direct current conversion equipment is 156,300 kw, of which 75% is converted by mercury arc rectifiers and the balance by motor generator sets or rotary converters.

In 1952, an 86-mile 171 kv transmission line was built to link Cominco hydro plants with operations in Kimberley. The line follows the Kootenay River and West Arm of Kootenay Lake, crossing the main body of the lake with a span of two miles. When constructed, this was the longest span in the world. A 60 kv branch line from Crawford Bay on Kootenay Lake supplies power to the Bluebell Mine at Riondel. The main line proceeds easterly over a 6,200-foot summit and beyond, carrying power to Cominco's Sullivan Mine, Sullivan Concentrator, Kimberley Fertilizer Department and Iron and Steel Smelter at Kimberley.

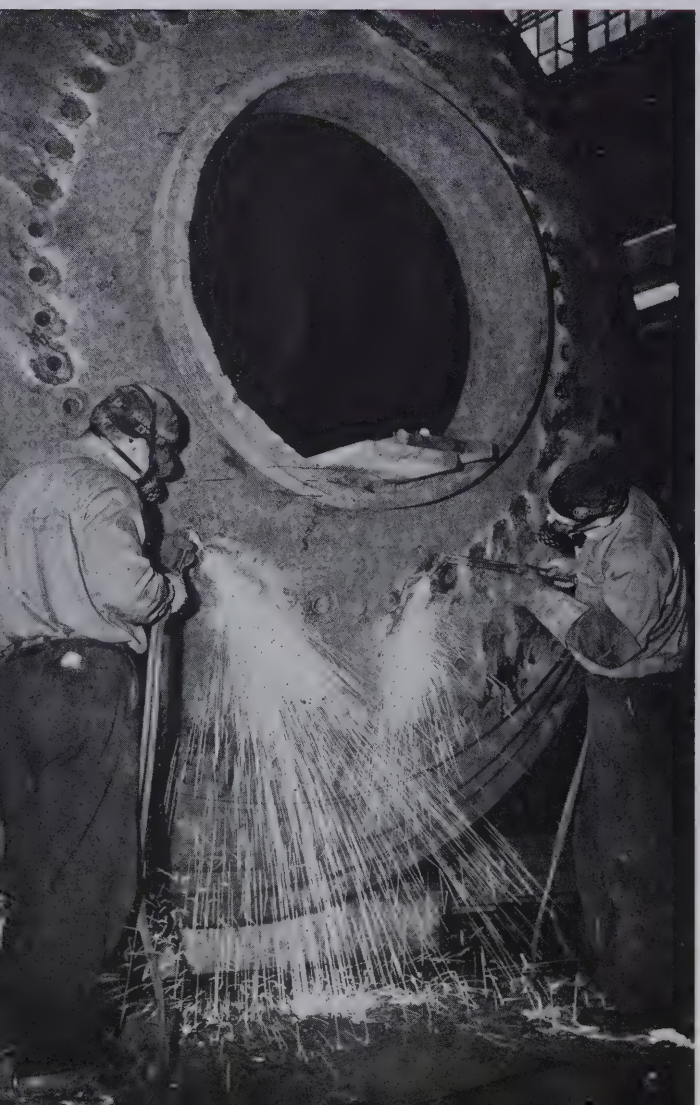
Cominco operates a 4,700 h.p. hydro plant at Bluefish Lake near Yellowknife, NWT, serving the Company's Con Mine in the area. Cominco also owns a 6,600 h.p. plant at Wellington Lake, Saskatchewan, which is operated and used entirely by Eldorado Mining and Refining Limited.

The electrolytic refining of lead typifies the industrial use of electric power. Cominco's Trail operations alone consume enough power for a large city, over 1¾ billion kilowatts per year. The Kimberley plants are also substantial consumers.

Control of water storage in Kootenay Lake is a major function of the Corra Linn Power Plant near Nelson. The plant has a rated capacity of 57,000 h.p. It was completed in 1932 as part of a long-term power development project.

Engineering

Extensive and Well Equipped



COMINCO'S Engineering Division has four main functions: the maintenance of widespread and varied operating plants; the operation of a number of trades shops; the supply of utilities and services such as water, steam, transportation, etc.; and the design and construction of new plants, and improvements to existing plants.

Although the Division has technical responsibility for operating plant maintenance, and administers the preventive maintenance program, much of the routine work is done by the plants themselves through assigned repair crews. However, maintenance jobs beyond their scope are carried out by main shop tradesmen. Some 2,500 men, including plant maintenance crews, are engaged in Engineering work at all Company operations.

Since Cominco's Kootenay operations are not near the adequate maintenance facilities found in large centres, the main Engineering shops at Trail are extensive and well equipped. Thus serious production delays due to equipment failures can be avoided.

The Trail shops include a modern Foundry where castings ranging up to 14 tons can be made. Most are of iron or steel or their alloys but many brass, bronze and lead parts are also cast.

A Pattern Shop is associated with the Foundry. It is staffed by expert tradesmen who make the replicas or patterns of wheels, pump casings and numerous other mechanical parts. They can, when called upon, make plant models for the design engineers, or patterns for ornamental items.

A full range of machine tools to handle all classes and sizes of work up to 25 feet in diameter and 35 feet long is available in the Tadanac Central Machine Shop. The Electric Shop can repair and rewind motors up to 3,000 HP and transformers to 10,000 KW capacity. The other shops at Trail include Instrument, Carpenter, Paint, Rubber, Lead Burner, Forge, Bricklayer, and Boiler and Welding. These and the maintenance shops at Kimberley, Calgary and other operations are staffed with fully skilled tradesmen. As a result, practically every emergency at any operation can be handled by Cominco shops.

The main Engineering shops at Trail are capable of fabricating and repairing production equipment, thus avoiding serious breakdown delays. A recent example was the Sullivan Concentrator's rod mill, shown during rush repairs.

The Tadanac Central Machine Shop is equipped with a full range of machine tools to handle all classes and sizes of work up to 25 feet in diameter and 35 feet long. It is one of the largest in Western Canada.

A Design Department employee prepares mechanical drawings of new equipment. The department is responsible for the design of a wide variety of projects, from mine hoists to multi-million dollar operating plants.

The Construction Department provides engineering supervision and cost control of all construction work. An example is the Kimberley Iron and Steel Plant, shown during the erection of main buildings early in 1960.

An important Engineering Division responsibility is the supply of utilities and services. Direct current electrical power for hydrogen production comes from these rectifiers located at the chemical and fertilizer operations in Trail.

Certain shops, particularly at Trail, are capable of manufacturing large pieces of special equipment. Examples include a 10-foot-wide by 60-foot-long sintering machine for the Lead Smelter, 10-foot ball mills for Kimberley, electric locomotives and cars for the narrow gauge railway, sand pumps, and filters.

The shops also provide the Construction Department with crews and trades supervision for most construction projects. The $2,600,000 Chlor-Alkali Plant at Trail is a recent example. The Construction Department provides engineering supervision and cost control of all construction work, including that done by outside contractors. It has an Estimating Section which calculates the costs of the various construction and plant improvement projects.

The Design Department is centred at Trail but is represented at all major operations. It is staffed by men who bring together broad experience in the engineering fields. They formulate and design such diverse projects as mine hoists and headframes, complex mechanical equipment or an entirely new multi-million dollar operating plant. An example is the $20,000,000 Iron and Steel Plant project started at Kimberley in 1960.

A Materials Engineering group provides specifications for particular material requirements and investigates all failures. They are fully equipped with all non-destructive testing equipment including X-ray, isotope gamma ray, and ultrasonic instruments.

At Trail alone, an average 5,800,000 pounds of steam per day is supplied from waste heat, coal-fired and electric boilers for plant processes and general heating. Water consumption for the Trail operations during 1959 averaged over 55,000,000 Imperial gallons per day, pumped from the Columbia River. A battery of 10 electric pumps lifts this water 315 feet to a reservoir where it is chlorinated and distributed by gravity to the Tadanac plants, or pumped a further 470 feet to the Warfield plants.

Transportation of all materials not handled directly by standard gauge railway is also an Engineering Division responsibility. Operation and maintenance of power shovels, mobile cranes, tractors, etc., a truck and passenger car fleet, and several miles of narrow gauge railway are under the Engineering Services Department. In addition, this department provides labour crews, janitor services, the operation of the Company nursery and dust control planting in the Trail area.

Personnel

Fair and Harmonious Relations

COMINCO'S consideration for its employees dates back to the formation of the Company; in fact, several elements of the Company's personnel program were in effect long before personnel administration had become a recognized aspect of industrial management. Some of the benefits and policies established in the early days were unique in industry. Cominco's personnel policies were broadened and developed further with the passage of time, and today the Company has a long-standing record of fair and harmonious relations with its employees and broad recognition for its activity in this field.

Although many personnel measures were in effect by 1928, this work was first formalized in that year with the establishment of an Employment Department. Expanded activities and responsibilities resulted in adoption of the name Industrial Relations Department in 1937. This was reorganized for similar reasons in 1946 as the Personnel Division. Since then the Divison's organization has varied according to its assignments.

The Personnel Division provides Company-wide services, assisting in dealing with day-to-day problems involving employee individuals and groups. Personnel policies are designed and administered to promote fair and uniform treatment.

Five major departments make up the Division: Safety and Hygiene, Welfare and Records, Staff and Training, Method Study, and Labour. There is also a Research and Statistics section. All are at Trail where the largest group of employees is located. The second largest group, at Kimberley, is served by a branch department. At other operations, Personnel matters are handled by the senior official in charge, or the Property Superintendent.

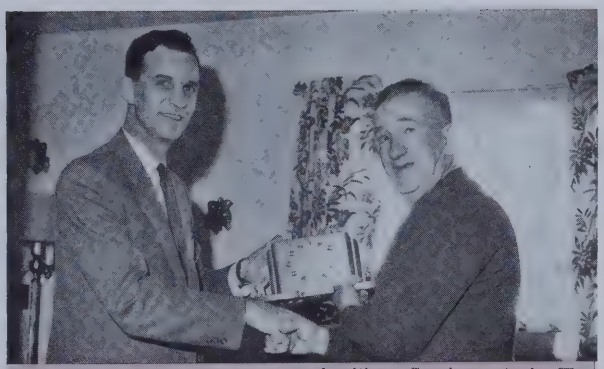
Safety and Hygiene

Safety is heavily stressed at Cominco. Regular programs of lectures, employee safety meetings, supervisors' meetings, contests, training courses and advertising are used. The slogan "Safety is Your Business" appears extensively. All programs are keynoted by the thought that, "No job we in Cominco do is so important and so urgent that we cannot take the time and effort to plan and to do it safely." Some very impressive Provincial and Dominion-wide records have been achieved. In the last category specific mention must be made of the H.B. Mine's record of being the safest mine in Canada in 1958 and 1959.

The Safety and Hygiene Department assists all Company operations in safety and industrial hygiene

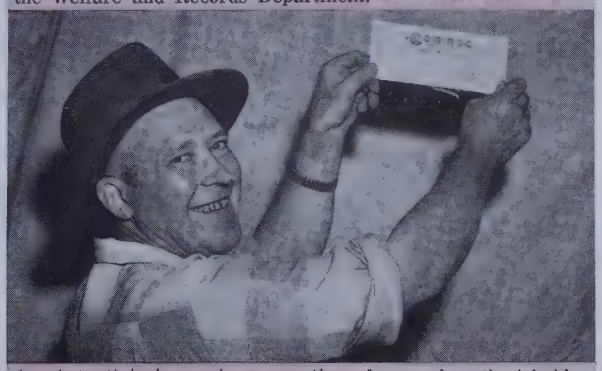
Shift change at the Con Mine, Yellowknife, N.W.T. Cominco's fair and harmonious relations with employees working at widely separated operations have earned broad recognition for the activities of the Personnel Division.

First aid training, a Safety and Hygiene Department function, features annual competitions. Winners earn coveted awards (above) and all trainees are competently aware that, on or off the job, their knowledge might save lives.



A retiring employee is presented with a Cominco clock. The Company's non-contributory pension plan with options, and a supplementary retirement benefit plan, are administered by the Welfare and Records Department.

Apprentice training in 14 different trades is undertaken by the Staff and Training Department. A high percentage of the graduates remain with Cominco as journeymen tradesmen, finding full and rewarding scope for their skills.



A substantial cheque in recognition of a good on-the-job idea rates a happy smile. Cominco's Suggestion Plan, supervised by the Method Study Department, has awarded a total of over $130,000 to hourly rated employee idea men.

work. This includes safety education and training, accident prevention, accident investigation, workmen's compensation, testing of new equipment, first aid and first aid training, preventive medicine, working conditions, and medical examinations. Safety Officers act in close co-operation with the senior officials in charge of operations.

Joint Management-Union safety and industrial hygiene committees meet regularly and inspect operations. The causes of every accident are analyzed and corrective measures are introduced where possible.

First aid training is promoted throughout the Company. All employees are encouraged to take St. John Ambulance courses and many hold Association awards. Company-wide first aid contests are yearly events. Supervisors are all required to hold a valid St. John certificate.

First aid facilities and ambulance services are maintained at all operations. At Trail, the Department directly supervises a first aid station staffed on a 24-hour basis.

The Department's Industrial Hygiene section pays, with the guidance of a medical doctor and senior research engineer, particular attention to working conditions and preventive measures in relation to occupational hazards. It also supervises pre-employment medical examinations and periodic examinations of selected employee groups depending on the type and location of their work.

Welfare and Records

The Welfare and Records Department deals with the formal benefit plans and the general welfare of employees and their families, including attendant records. In addition, housing accommodations, food services, contributions to welfare agencies, and other like matters are responsibilities of this department. All those records which are required to administer the benefit plans as well as employment history records of all hourly paid employees are maintained in the department. Much time is devoted to counselling employees on personal problems.

The group life assurance program covers hourly rated employees for $5,000 on completion of three months service. Salaried employees are covered in relation to annual earnings up to a maximum of $10,000. Monthly premiums are shared equally by the employees and the Company. The policy also provides for payment of proceeds to the assured on evidence of total and permanent disability commencing before the assured's 60th birthday. Reduced insurance coverage is continued in force on the employee's retirement.

Prepaid medical care plans are in effect at all Company operations. Under these, employees and their dependents receive comprehensive medical and surgical service with the premium cost shared by the Company and the employee. The Company also shares

Seeking the answer to a plant seniority question, an employee queries the Personnel Officer concerned. Personnel Officers, attached to the Labour Department, advise and assist operating groups at Trail and Kimberley.

the premium cost of prepaid hospital care in plans where a premium is required for public ward accommodation.

Employees at most operations receive benefits during periods of non-occupational sickness and accident through membership in employee-administered societies. Both members and the Company contribute regularly.

Employees are encouraged to own their own homes. Construction and home improvement loans are made available through the medium of the Pension Fund Society. Repayment is usually spread over a period of up to 15 years.

The non-contributory pension plan was introduced in 1926. Pensions are based on length of service and earnings during the last 10 years of service. Options include widow commutation, which permits an employee to arrange that his widow will be paid a partial pension should he predecease her, and an opportunity for the pensioner, at the time of his retirement, to integrate his pension with the Federal Old Age Security Pension. In 1958 the Company introduced a supplementary retirement benefit plan. This provides an employee on retirement with a monthly annuity in addition to his Cominco pension. The plan is under contract with a commercial insurance carrier; the amount of the annuity depends on the extent to which both the employee and the Company contribute. Company contributions are restricted to benefits based on the employee's pensionable service before June 1, 1958.

Staff and Training

The Staff and Training Department is responsible for Personnel practices, policies and records associated with salaried employees. Employees' training and communication programs for both salaried and hourly rated employees are also under this department.

Servicing Cominco's needs for salaried employees, the Department recruits, selects and places people in a wide range of occupations requiring a great variety of skills. The salaried staff includes almost four hundred university graduates in technical, supervisory and executive positions, as well as office staff, non-technical supervisors and technicians. Other functions include employee appraisal and salary administration, psychological services, leaves of absence, sick leave, annual vacations, transfers, employee records, etc.

Staff and Training administers several formal training programs. These include apprentice training in fourteen different trades leading to certification of qualified tradesmen, assayer training and supervisory training. There are also Engineer-in-Training programs for new technical graduates and vacation training programs for undergraduate students. Programs in specific areas such as vehicle operation and office procedures, are organized as required.

Communication programs include plant bulletin board news releases and pictures, a fortnightly supervisor's newsletter and maintenance of an up-to-date policy manual for supervisors.

All Company operations may call on the services of a full time psychologist. These include testing and screening job applicants, assistance in identifying and selecting people for positions requiring special interests and aptitudes, and general counselling of employees on personal problems.

Method Study

The Method Study Department gives Company-wide assistance in investigations involving work measurement, work methods and materials handling. It also investigates proposed expenditures involving plant or working layouts. Organizational studies and assistance in determining proper work standards as a basis for establishing and negotiating incentive contracts with employees in selected work areas are Method Study responsibilities. The Department also directly supervises an employee suggestion plan and evaluation of hourly paid and salaried jobs.

Detailed studies of hourly rates and the composition of hourly paid jobs led to a formal job evaluation system in 1942. This is still in effect. Since 1946 the evaluation of new hourly paid jobs and re-evaluations have been carried out by a joint committee of Cominco job analysts and employee representatives selected by the Union. As a result of studies begun in 1945, a plan for the evaluation of salaried jobs was introduced in 1947. With only minor modifications this is still used throughout Cominco.

Suggestion plans at all major operations include cash awards for accepted suggestions by hourly paid employees and recognition for successful salaried employee suggestors. Suggestions deal with improvement of equipment, processes, methods and safety.

Labour

The Labour Department gives Company-wide assistance on questions associated with the employment of hourly paid people. Examples are hiring and placement, conditions of work, pay and allowances, vacations, leaves of absence, etc.

The Department participates in collective bargaining with Union locals, administers collective bargaining agreements and deals with grievances and other matters involving relationship with the unions.

At Trail and Kimberley, Personnel Officers attached to the Labour Department, provide advice and assistance to operating departments on such things as placement, transfer, discipline and utilization of hourly paid employees.

Integral Divisions and Services

THE function of the Comptroller's Division relates to the financial aspect of the Company.

A complex accounting system services Cominco's many and varied activities. Payroll preparation alone requires the utmost care due to the numerous rates of pay and the many deductions made for personal income taxes and insurance, unemployment insurance, housing loans, etc. Modern accounting machines assure prompt payment of wages to all employees twice monthly.

The Accounting Department records the costs of essential activities such as exploration, mining, production, services, construction and sales. Costs of the various operating units are ascertained and kept to account for the value of materials in process and marketable products at all operations.

The calculation of income from Company activities, the preparation of financial statements for Cominco's various enterprises, and related details such as income and mining taxes, sales taxes and other statutory requirements of governments, are also important aspects of the work done by the Comptroller's Division.

* * *

The Legal Division's activities are divided into two departments—Legal and Patents. Fields covered include corporation law generally, legal drafting, legal research, mining law, patents and trade marks, public utilities and power, labour law, real estate, insurance, and real property taxes. On occasion members of the Division act as counsel representing Cominco in court and before government and other boards.

The Division also maintains records and titles of all mining claims and real estate and attends to real property taxation.

Requests for the assistance of the Legal Division may originate from any source within the Company or its subsidiaries.

* * *

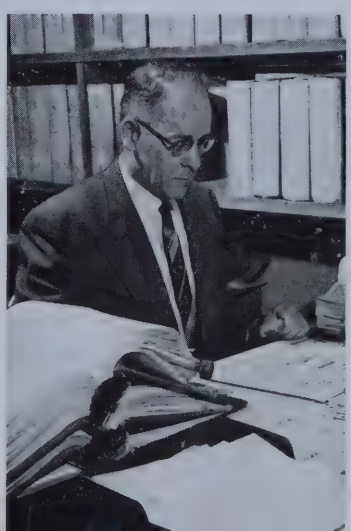
The Purchasing Division is divided into three departments — Purchasing, Traffic and Stores. Purchasing undertakes the purchase and warehousing of manufactured supplies and equipment for Cominco's operations, together with the movement of these supplies and finished products. The Department is responsible for all purchasing and looks after enquiries, orders, shipments, price checking and recording.

The Traffic Department handles all incoming and outgoing freight and express shipments, and maintains a continuous audit of rates and other charges. Air shipments, water transport, customs duties, personnel movements, etc., are also Traffic functions.

The Stores Department mainly receives, warehouses and issues all operating and maintenance supplies. It also attends to salvage and the disposal of used equipment.

* * *

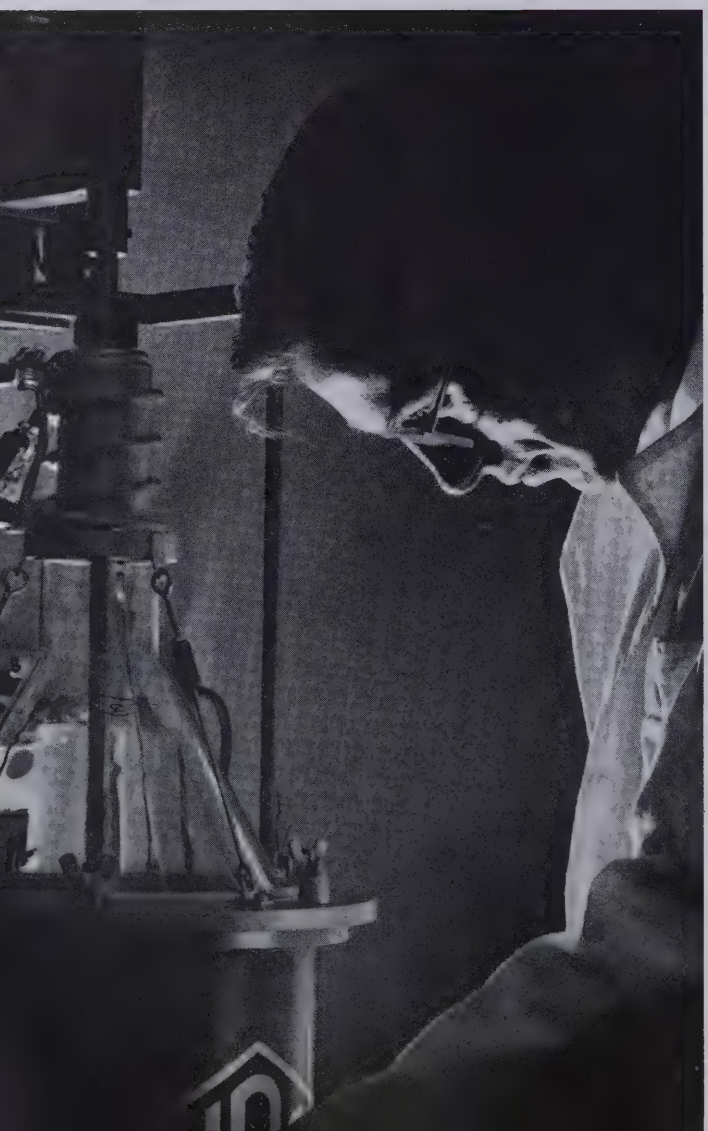
Budgetary control, internal security, supervision of files and records, advertising, and public relations are the responsibilities of specialized groups within the Company.



Top left: Comptroller's business machines handle payrolls. Top right: Trade marks like Elephant Brand are Legal responsibilities. Bottom left: Freight rates are studied by Purchasing. Bottom right: Files and Records is a service.

Research and Development

Active in Many Fields



RESEARCH has played a major part in the operations and in the growth of Cominco. As in so many companies, it had its early beginnings in the efforts of plant operators to improve their processes and solve their difficulties by careful experimentation right on the job. The introduction of the electrolytic zinc process in 1916, however, brought with it problems too complex to be solved in this way, and the following year saw the establishment of the first research laboratory at Trail. From that time research has had official status at Cominco.

The Research and Development Division has been associated with most of the expansion and technical achievements of the Company, and has grown in scope and size until, at present, it employs about 200 people. About half of this number are employed in the Central Research Laboratory, and the others are occupied in development work in the mining, metallurgical, chemical and engineering divisions.

The present activities of the Division cover a variety of fields. First of all, plant processes and operations are under constant scrutiny by the development engineers stationed in the operating plants. This work has resulted in continued improvement in the efficiency of the plants and in the quality of the many products. New operating techniques are worked out by close collaboration between these engineers and others in the laboratory where procedures can be tested and new data can be derived under controlled conditions. To assist in the work of the development engineers, there are branch research laboratories attached to the operating plants. Included among these are the laboratories at the Sullivan Mine and Concentrator, at the Chemicals and Fertilizers departments at Warfield, Calgary and Kimberley, and in the Zinc Plant and Refinery at Trail. Men in these laboratories are very familiar with the operations to which they are attached and specialize on the problems related to them.

Closely related to plant operations are smoke control and smoke treatment research, which are concerned with the control of solid and gaseous emissions to the atmosphere, for the reduction of atmospheric pollution and the avoidance of waste of valuable products.

The Research and Development Division is also very active in the development of new products and processes, and through the past has had an important part in the successful launching of such major expansion projects as the separation of Sullivan ore, the

A Central Research Laboratory employee examines equipment used to grow crystals of high purity indium antimonide. Cominco supplies electronics industries with a wide range of high purity metals and alloys.

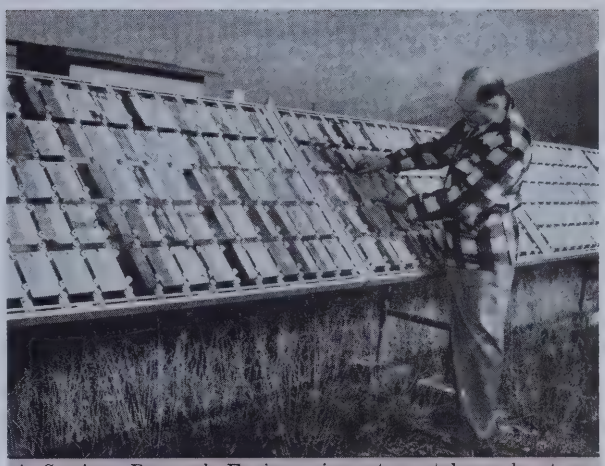
production of fertilizers, the fuming of blast furnace slag, and the recovery of sulphur dioxide and, more recently, much of the development leading to the new iron and steel project.

Indium was first prepared in the laboratory from Trail smelter by-products in 1941, but due to lack of demand there was little further activity until 1949 when a richer source of indium was discovered, and intermittent production was undertaken for sales development. By 1955 a larger plant was needed to meet growing demands. Developments in the electronics industries created requirements for indium and indium alloys of extremely high purity, and refining processes were devised to satisfy these. Similar processes and other refining steps have been applied, not only to indium, but also to antimony, arsenic, bismuth, cadmium, lead, silver, tin and zinc to give a wide range of high purity metals for electronic products, and for use in research.

New fields of research entered by Cominco during the past decade are concerned with the development of markets and the uses for products. The Metal Use Research group has reviewed and studied the properties of lead and zinc and the uses of these metals in industry. Scientific help and advice is freely given to customers in the use of these metals, as a means of improving the competitive position of the metals and stimulating wider use. New fields of usefulness have been studied and arising from these studies have been the commercial development of Cominco zinc anodes for the protection of steel ships and structures from corrosion by sea water, the development of extruded zinc sections for use in terrazzo flooring, and other shapes being produced in the Metal Fabrication Plant. Similarly the Fertilizer Product Research group has been active in the production of new high analysis dry and liquid fertilizers specially adapted to the needs of customers.

The Research and Development Division also includes a number of service departments for the use of its own staff and the Company at large. Included in these are the Central Technical Library, which has at its disposal one of the most complete sources of technical information in Western Canada. The Materials Testing Section is fully equipped for the evaluation of a wide variety of products.

The Analytical Section is equipped with the most modern equipment for performing special analyses and examinations. This section is playing an essential part in the development of the high purity metal products containing less than one part per million of total impurities, which have placed Cominco in the forefront of this new industry.



A Cominco Research Engineer inspects metal panels at an Atmospheric Exposure Testing Station. Results of corrosion research are applied to the development of many types of longer-lasting products.

An operations research group is available to give assistance to all branches of Company operations that can be helped by mathematical analysis of their problems, whether they be of a purely technical nature, or related to matters of sales and distribution.

There is a variety of specially equipped laboratories. These are available for metallographic study of metals, corrosion studies, electrolytic, vacuum and zone-refining of metals, and organic chemistry. A furnace room is equipped with induction and resistance furnaces for the melting and casting of metals, and a semi-pilot plant area is equipped for process and fabrication work on a larger-than-laboratory scale.

Research and Development has a simple organizational structure. Working under the manager and assistant manager are a number of senior research engineers, each of whom takes responsibility for certain phases of work. Under each is a team of scientists, many of them specialists in their fields. Close contact is maintained between senior research engineers and plant development personnel throughout all the operating divisions of the Company.

Research is more than a group of laboratories; even more than the people who work in them, or in plant development. It is a quality of mind that spreads its influence throughout Cominco. It is a questioning and evaluation of all that we do and have—a building on the foundations of past achievement to construct future success. Though its policies are consistent, its emphasis is constantly changing as it completes its assignments, solves its problems and moves on to others. Its direction cannot be predicted too precisely or too far into the future. If it could, much of the research might not be necessary. But the experience of the past and faith in the future are assurances that the direction of research will always be forward, to the greater benefit of Cominco.

The Central Technical Library ranks with the most complete sources of technical information in Western Canada. It is one of several service departments included in the Research and Development Division.

Product Sales

An International Activity

COMINCO'S position as a major producer of lead and zinc, accounting for about 6% of the total world output of each metal in recent years, is well known. Perhaps less widely recognized is the Company's position as a pioneer in the production and purification of many metals such as cadmium, bismuth, silver, gold, arsenic, antimony, tin and indium.

These, in addition to lead and zinc, now constitute the metal products sold internationally by Cominco. They are marketed in numerous physical shapes such as wire, slab, shot and ribbon, and in many grades of purity. The range of products grows and becomes more diversified each year as research unfolds new techniques for metal separation and purification, and as new markets for metals and their alloys are found.

Recent developments by Cominco involve the production of metals and rare alloys of extreme purity which have applications in expanding fields of electronics, thermo-electric devices and communication.

A major diversification for Cominco is the establishment of an iron and steel industry in Western Canada. Pig iron, a product of 1960, is one which will be followed by a broad range of steel products in the near future.

It is the responsibility of the Metal Sales Division to sell all Cominco metals (these are marketed as Tadanac Brand and Cominco Brand) in co-operation with Research and Development, Sales Development and Market Research.

Geographically, Cominco's metals are distributed in approximately equal proportions to three major markets: Canada, the United States, and the United Kingdom. A small but important tonnage moves to other export markets such as Brazil, Mexico, Japan, Korea, the Philippines, India, and Continental Europe. These markets are of particular significance to the future of Cominco. Many are "have not" nations with respect to base metal reserves and are entering a period of explosive economic acceleration. They are the growth markets of future decades, and are expected to absorb an increasing proportion of Cominco's expanding metal output.

The activities of the Metal Sales Division are directed from Cominco's Head Office at Montreal. In Canada, sales are made directly by Cominco sales personnel from Montreal and from branch sales offices located at Toronto, Winnipeg, Calgary, and Vancou-

An employee at Cominco's Lead Refinery (above) wires bundles of 100-pound lead pigs for shipment to a customer. As a major lead and zinc producer, the Company accounts for about six percent of the total world supply of both metals.

Chemical fertilizer is removed from storage at the Alberta Nitrogen Department on the first leg of its journey to a farm customer. Cominco is one of the largest producers of chemical fertilizers in North America.

ver. In most other markets, sales are made through agents who specialize in their respective areas. In the United States, sales of lead, zinc, alloys of lead and zinc, and cadmium are made by an agent. Other products—indium, high purity metals, and bismuth—are sold directly by Cominco sales personnel.

In the United Kingdom and Europe all metals are sold through an exclusive agent. Similarly, exclusive agents have been appointed for Korea, Formosa, Japan, India, Pakistan, Brazil, and most principal overseas markets.

Cominco's agents are selected with great care. Their qualifications are a high ethical standard of business conduct, a keen awareness of market trends and the activities of competitors, the ability to communicate and assist in developing promotional and advertising programs and, particularly important, a technical knowledge of Cominco's metals and their uses.

Cominco is one of the largest producers of chemical fertilizers in North America with a total yearly production of some 700,000 tons of various fertilizer materials. The sale of this output is the responsibility of the Chemical and Fertilizer Sales Division with Head Office at Montreal and branch sales offices at Calgary, Saskatoon, Winnipeg and Vancouver. Sales in the United States are handled by a wholly-owned subsidiary, Cominco Products Inc., of Spokane, Washington, whose exclusive sales agent is Balfour, Guthrie & Company of San Francisco. Cominco's fertilizer products are marketed under the well known Elephant Brand label in all markets served.

Sales in the U.S. account for the major part of Cominco's fertilizer output. The area covered extends from the West Coast through the Intermountain region into the Midwestern states, taking in a total of 22 states including Hawaii and Alaska. Due to Cominco's location, the Canadian Prairie provinces and B.C. are prime Canadian fertilizer markets, but substantial tonnages are also sold in the Eastern provinces. Offshore export markets make up another important sales area and Elephant Brand fertilizers are well known in India, Korea, the Philippines, Pakistan, Indonesia, Thailand, Colombia, Chile, Peru and Guatemala.

While dry products comprise the major portion of Cominco's fertilizer sales volume, a rapid growth in liquid fertilizer sales has been realized since the introduction of these products to the Northwest U.S. market in 1956. Sales of anhydrous and aqua ammonia as well as various liquid combinations of nitrogen, phosphoric acid and sulphur are marketed through a network of direct dealers in the area.

Product diversification to meet the varying demands of crop and soil requirements is an important factor in the sales program, and the flexibility of Cominco's production operation results in a wide range of products adapted to specific usages. This flexibility was further enhanced in both dry and liquid programs by the addition of urea to the product line in 1960.

The Sales Division maintains a supervisory technical service staff of trained agriculturists who work closely with government and university authorities and with the network of Elephant Brand agents, distributors and dealers in market areas. Demonstrations and educational programs are undertaken constantly to keep fertilizer consumers abreast of the latest fertilizer developments and practices.

Many overseas consignments of Cominco-produced metals and chemical fertilibers are loaded aboard ships at Pacific Coast Terminals facilities, New Westminster, B.C., or Pacific Coast Bulk Terminals at Port Moody, B.C.

Apart from fertilizers, the Chemical and Fertilizer Sales Division is also responsible for the sale of chemical products to industry. Sales of sulphuric acid and sulphur dioxide represent a substantial sales volume in Canadian and U.S. markets. Anhydrous ammonia, aqua ammonia and ammonium nitrate are also sold for industrial consumption, mainly in the Canadian market. The production of chlorine and caustic soda is further broadening Cominco's sales interest in chemicals for industry.

With the intensely competitive markets of today, continuing efforts must be made to retain the traditional outlets for products as well as to establish new markets. The rapid growth in technology in recent years has resulted in a high rate of product obsolescence, making necessary the constant development of new and improved products. To deal with the rapidly changing market situation, Cominco maintains an active Sales Development group.

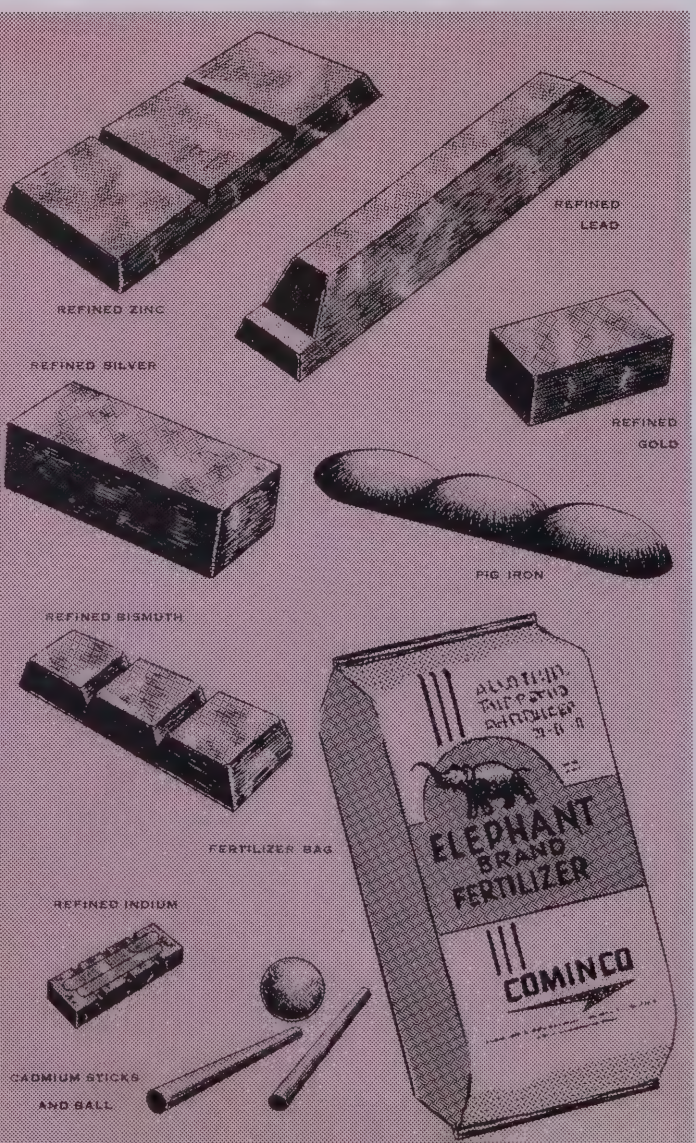
Activities cover a broad range but, in general terms, the overall objective is to stimulate the demand for both new and existing Cominco products. In this work, the proper performance of Sales Development functions requires close co-ordination with Sales, Research and Development, Market Research and Production.

In the promotion of existing products, Sales Development keeps in close contact with the various industrial associations promoting the use of these products, and with the consuming industries. In addition, technical service to customers, the distribution of technical information and co-operation in advertising and publicity on Cominco products, are all important facets of Sales Development activity.

In new product promotion, activities range from the initial introduction of the product, through the build-up of sales volume and channels of distribution to the stage where a commercial market has been proved. Then the appropriate Sales group takes over. Examples are electronic materials, zinc anodes for cathodic protection and other zinc and lead fabrications.

Product Uses

Many Important Applications



COMINCO-produced metals are present in thousands of items used at home, at work and at play. In many cases the presence of lead, zinc, or other Cominco metals is not recognized because these metals are often alloyed or coated with other metals such as chrome.

A complete list of uses for metals produced by Cominco would fill many pages. The following is a summary of the more important applications.

Zinc

Zinc is one of the leading weapons in the battle against corrosion with a record of over 100 years of successful performance.

As a coating for steel, it protects many products against rust. Hot dip galvanizing, the old reliable method for applying a coating of zinc on steel, uses almost half of the world's zinc production. Since World War II, continuous galvanizing of cold rolled strip has increased considerably.

There are many galvanized products in use today, such as roofing sheet and strip, siding, all-metal buildings, ducts, gutters, culverts, automobile body pressings, barbed wire, chain link fencing, transmission towers, pole line hardware and plumbing fixtures.

Zinc is also used in another way to protect steel from corrosion. Zinc anodes are in use throughout the world to protect the hulls of ships, steel docks or steel in any situation where it is in constant contact with water. The zinc anodes, connected to underwater structures, corrode sacrificially while the steel remains intact. The zinc anodes can be replaced easily and economically.

Die-casting is the second largest outlet for zinc. With pressure die-castings, manufacturers are effecting production economies in making intricate parts for business machines, electrical equipment, household appliances, and automobiles. Some of the more common zinc die-cast products are: instrument clusters, locks, door handles, carburetors and grilles of automobiles, domestic appliances, office and business machine parts, plumbing fittings, taps, towel rails and general hardware such as locks, handles and knobs.

Brass-making also consumes a great deal of the world's zinc production. A zinc-copper alloy, brass is used for screws, costume jewellery, machined parts, electrical fittings, plumbing fittings, ammunition and decorative metalware.

Rolled zinc is used in dry cell battery cases, organ pipes, preserving jar rings, photoengraving, lithog-

raphy and addressing machine plates. Zinc oxide is used in paints and pigments, pharmaceuticals, rubber, glasses and glazes.

Lead

The oldest known specimen of lead is a figurine dating from 3,000 B.C. Since then, man has used this metal down through the ages in many varied ways.

Storage battery manufacture, one of the better known uses for lead, is also the largest single consumer of the metal. Lead as an antiknock compound (tetraethyl and tetramethyl lead) in gasoline is another major outlet.

Lead is also used extensively in solders, alloys, ammunition, type metal, ceramics, piping, cable sheathing, paint, pressure-relieving joints, anti-vibration mats, stair treads, putty, sheets under tiling, leaders, gutters, sash weights, flashings, caulking, spandrels, nails and blasting mats.

Modern technology has opened up a variety of new uses for this timeless metal. Some of the latest jetliners are using lead to reduce noise and vibration; in the field of nuclear research lead is used as a shield against radiation; lead alloy anodes in impressed current systems for corrosion protection of steel are finding applications in ships, bridges, piers and power plant condensers.

Iron

Iron, a new Cominco product of 1960, is the most useful metal known to man. Most of the world's iron production is used in steel making, although large tonnages are also being consumed in a wide range of cast and wrought iron products.

Production from Cominco's Iron and Steel Plant at Kimberley, B.C., is directed to a variety of Western Canadian industrial markets.

Silver

Most of the silver produced today is used in a silver-copper alloy to make coins, although large amounts of this metal are also being consumed in the manufacture of photographic film and paper. Smaller amounts of silver are used for silverware (sterling and plate), medals, electrical contacts and chemicals.

Gold

In addition to gold sent to the Canadian Mint for monetary purposes, the metal is also used in different types of jewellery, dental alloys and certain industrial applications.

Bismuth

The major use of bismuth is in the form of salts for medicinal purposes. Because bismuth has a low melting point, it is used in alloys to take advantage of this feature, such as automatic sprinkler systems. The metal is also used in the manufacture of X-ray tracers, artificial pearls, cosmetics and solders.

Cadmium

Most of the world's cadmium production is used for electroplating. Other amounts are consumed in the manufacture of bearings, solders and various alloys.

Antimony

Antimony is used in storage battery grids, for type metal (antimonial lead), vitreous enamels, lacquers and fireworks.

Indium

In recent years, high purity indium has been used extensively in the electronics industry. The principal use of indium in this field is in the manufacture of rectifiers and transistors. The functioning of a germanium transistor, for instance, which depends on changes in the properties of germanium may be caused by the addition of a carefully controlled amount of indium. For these purposes, the high purity indium must be fabricated in exacting shapes and sizes. This fabrication is now being carried out at Cominco's Electronic Materials Plant at Trail.

Indium is also used in the production of high speed bearings, low-melting point alloys and solder alloys.

Fertilizers

Cominco's chemical fertilizers are used in North and South America, Asia and elsewhere for almost every type of crop. These fertilizers, in both dry and liquid states, are applied to increase yields, produce high protein crops, promote faster growth and control weeds.

The largest single market for these fertilizers is grain crops. Others such as fruit, vegetables, hay crops, livestock pasture and forestry consume varying amounts.

Important Fertilizer Products*

Phosphate Fertilizers

11-48-0	23-23-0
13-39-0	24-20-0
16-48-0	27-14-0
16-20-0	

Complete Fertilizers

8-32-16	14-14- 7
10-30-10	13-16-10
13-13-13	

Nitraprills

33.5-0-0

Ammonium Sulphate

21-0-0

Urea

45-0-0

Liquids

Anhydrous Ammonia
Aqua Ammonia
Ammonium Phosphate Solution (8-24-0)
Ammonium Nitrate Solution
Nitrogen Sulphur Solution
Urea Nitrate Solution
Phosphoric Acid

* Elephant Brand is Cominco's well-known trade mark for chemical fertilizers.

The Story in Figures

A Phenomenal Growth

TO understand the scope of Cominco's activities easily, the consumption of raw materials, the production of intermediate and end products and some financial statistics have been resolved to a typical daily basis. Many of these figures are based on 1959 totals which may change substantially in the course of time.

Annual Production

Year	Lead (tons)	Zinc (tons)	Silver (ounces)
1894 to 1949	4,707,293	3,156,710	235,344,567
1950	170,364	156,021	12,120,568
1951	162,712	164,513	14,417,391
1952	183,389	161,357	12,965,511
1953	166,356	185,859	16,144,791
1954	166,379	147,776	11,901,184
1955	149,795	190,910	10,082,187
1956	149,262	193,041	11,583,530
1957	144,017	189,295	10,877,532
1958	134,827	193,514	12,875,160
1959	140,881	194,499	9,367,029
1894 to date	6,275,275	4,933,495	357,679,450

Year	Gold (ounces)	Cadmium (tons)	Bismuth (tons)	Tin (tons)
1894 to 1949	3,213,478	6,113	1,705	3,173
1950	62,186	349	97	398
1951	74,347	542	104	173
1952	84,347	338	71	106
1953	91,321	420	36	348
1954	96,395	467	113	173
1955	89,071	759	80	252
1956	97,428	884	78	328
1957	95,403	901	73	400
1958	69,962	643	86	360
1959	66,117	838	91	246
1894 to date	4,040,055	12,254	2,534	5,957

Year	Dry Fertilizer (tons)	Liquid Fertilizer (tons)
1894 to 1949	4,361,188	
1950	542,636	
1951	557,776	
1952	593,455	
1953	599,996	
1954	693,949	595
1955	678,802	10,193
1956	673,044	20,449
1957	630,622	32,373
1958	656,697	45,714
1959	620,162	56,046
1894 to date	10,608,327	165,370

Ore Mined Per Day

Sullivan Mine	10,000 tons	Con-Rycon	520 tons
Bluebell Mine	700 tons	Phosphate Mines	1,000 tons
H. B. Mine	1,250 tons		

Raw Material Required Per Day

Coal	300 tons
Coke	180 tons
Natural Gas	14,200,000 cu. ft.
Hydro Power	345,000 h.p.
Water	103,000,000 gal.

Metals Produced Per Day

Lead	400 tons	Cadmium	2 tons
Zinc	530 tons	Bismuth	¼ ton
Silver	25,000 oz.	Tin (as concentrate)	1 ton
Gold	181 oz.		

Chemicals and Fertilizers Produced Per Day

Sulphuric acid	1,500 tons
Ammonia	560 tons
Chemical fertilizers—at Trail	1,500 tons
at Kimberley	200 tons
at Calgary	300 tons

Financial Highlights Per Day

Sales	$300,000
Income, mining, property tax provision	$ 35,000
Manufactured supplies, fuel, etc., purchased	$ 50,000

"The Consolidated Mining and Smelting Company of Canada Limited is not dependent upon any single mine, nor upon any single mining district; but its interests and business, besides being to an extent industrial, will also be so diversified as to minimize, so far as possible, the speculative element."

These words were written by W. H. Aldridge, Managing Director, in 1906, a few weeks after the new Company had been formed.

Now, more than a half-century later, Cominco is a company which has many mining operations and future mining possibilities, metallurgical plants which produce lead, zinc, iron, silver and six other metals, chemical plants which produce substantial tonnages of fertilizers and industrial chemicals, hydro-electric plants, plants which produce such items as fabricated metals, electronic materials, die castings and fertilizer applicators; and has other related interests as well.

As the years pass this list will grow, for Cominco looks to the future with confidence and vigor. An early Managing Director's resolve became an enduring corporate spirit.